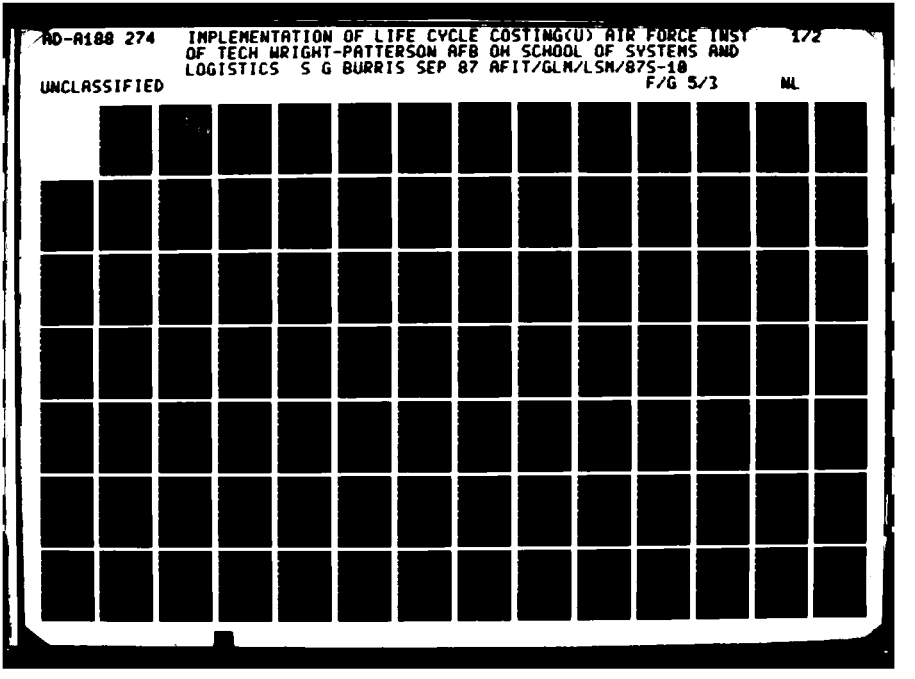
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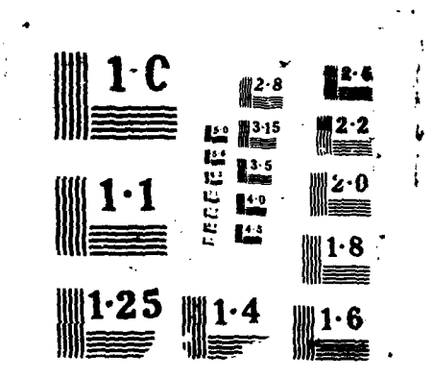
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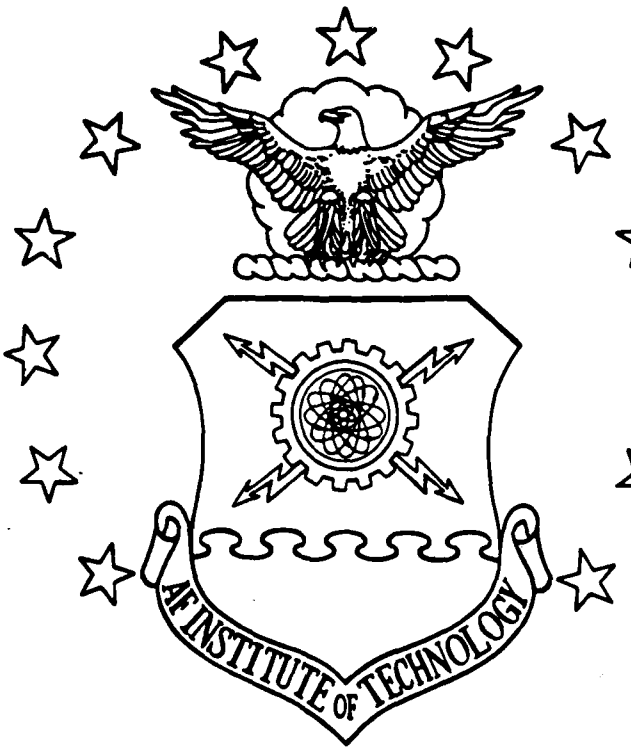






DEPARTMENT OF THE AIR FORCE

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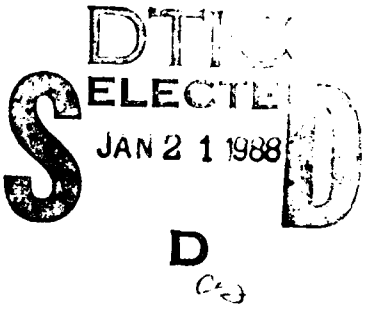


# IMPLEMENTATION OF LIFE CYCLE COSTING

THESIS

S. Gregory Burris
Captain, USAF

AFIT/GLM/LSM/87S-10

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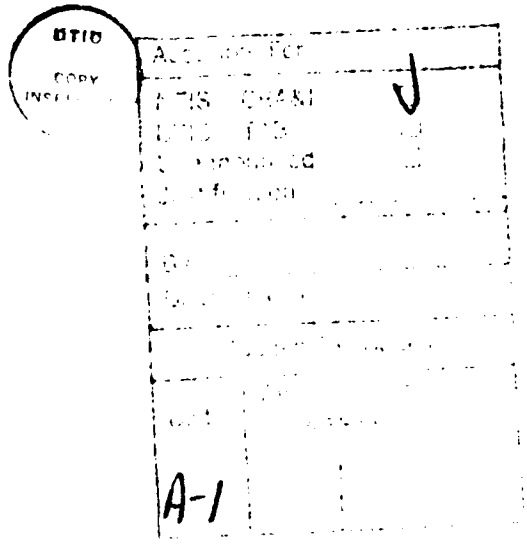

AFIT/GLM/LSM/87S-10

# IMPLEMENTATION OF LIFE CYCLE COSTING

THESIS

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the

Requirements for the Degree of

Master of Science in Logistics Management

S. Gregory Burris, M.S.

Captain, USAF

August 1987

## Preface

The objectives of this research study are to determine the current status of life cycle cost management, whether it is effective in meeting its objectives, and to what degree. The intent is to present an overview of how life cycle costing is currently being implemented and utilized in DoD, and more specifically in the U.S. Air Force. The study also identifies factors which contribute to the weaknesses of life cycle cost management, and determine what changes could result in more effective and productive application.

This thesis would not have been possible without the patience and help of others. I owe the completion of the thesis to the endless concern, patience, and advice of my faculty advisor, Charlie Youther. Without the three or four thousand corrections he provided this thesis would have been a waste of several good trees. I would also like to express my appreciation to the Course Director for Research Methods, Captain Carl Davis. He enlightened me with reality and logic, and allowed me to get off on the right foot. In particular, I wish to thank my lovely wife Laura for her understanding, concern, and affection during the many months of this ordeal. My effort on this thesis could not begin to compare with the burden she willingly accepted.

S. Greg Burris

## Table of Contents

## List of Figures

## List of Tables

## Abstract

The conditions and events which served to highlight the fact that life cycle cost (LCC) had been ignored in the past and is being poorly utilized in the present are discussed. Mind-sets and faulty prioritizations which may prevent life cycle costing's successful implementation are also discussed. The significance of reliability and maintainability (R&M) to LCC, its role as the major LCC contributor, and its potential for greatest savings are addressed. The timing of LCC management emphasis and of trade offs, current guidance and direction, recommended methods of implementation, and current types of cost estimating models available and commonly utilized are also brought out.

# IMPLEMENTATION OF LIFE CYCLE COSTING

## I. Introduction

### Background

According to General James P. Mullins, USAF, (Ret.), the Department of Defense's (DoD) reliance on complex and sophisticated equipment, and its failure to properly emphasize the impact of factors which substantially increase the life cycle cost (LCC) of systems, has resulted in a tremendous investment required to keep those systems operational (Mullins:12-13). Richard D. Webster, the Deputy Assistant Secretary of Defense for Logistics and Material Management, stated in 1982 that the research and development and procurement costs associated with a system's life cycle have increased, and "the cumulative operations and support cost over the life of major weapon systems invariably exceeds total development and production costs" (Webster:5-6). James P. Wade, the Assistant Secretary of Defense for Acquisition and Logistics, stated that in addition to affecting DoD's ability to effectively manage current procurements, rising LCC are decreasing funds available for future system development. Recent program cost overruns and increasing budgetary constraints have resulted in closer public and congressional scrutiny and criticism of DoD's procurement process (Wade:27-29).

Overview of the Problem

The importance of LCC became even more obvious as budget problems started to occur. Webster summarized one of the changes in system life cycles as follows:

> When we began thinking about life cycle cost some 20 years ago, our frame of reference for a system's life was 10 to 15 years. Experience has shown us, however, that the lifespan of a system is sometimes twice that long [Webster:5].

Colonel Gene S. Bartlow, USAF, Chief, Congressional Activities Division, sighted funding instability as one of the most visible difficulties in weapon system acquisition. He stated the following:

> Often, instability [of funding] reflects concern over a weapon's performance but too often this finds its origins in the Congress. Erratic swings in research and development money, reflecting congressional direction, is a chief cause of later cost growth and other problems in weapons system acquisition [Bartlow:14].

Bartlow noted the trend towards more complex and capable aircraft, and that less aircraft are being built at a higher cost due to spiraling weapon systems costs; and he concluded that "the problem is readily recognizable and something must be done about it now" (Bartlow:17).

The general consensus appears to be that with increasing life-spans and system costs, and the fact that operation and support costs typically represent an even larger expense than that of system acquisition, military planners will have to compute LCC better if more accurate budgets and budget projections are to be possible. To

accomplish this, military procurement agencies are developing methods and procedures to better break out and define the total LCC. It would appear that it is also important that procedures are developed to ensure timely and effective application of life cycle costing and trade-offs in order to derive the most benefit from available funds.

## Specific Problem

Evidence suggests that there is inadequate monitoring and control of LCC and that improved implementation of LCC management would be beneficial. In view of the current concerns, there is a need to review present LCC implementation and to determine how improvements in implementation might be achieved.

## Objectives of the Study

The objectives of this research study are to determine the current status of life cycle cost management, whether it is effective in meeting its objectives, and to what degree. The intent is to present an overview of how life cycle costing is currently being implemented and utilized in DoD, and more specifically in the U.S. Air Force. The study also identifies those factors which contribute to the weaknesses of life cycle cost management, and determines what changes in this process could result in more effective and productive life cycle cost application.

## Investigative Questions

In order to determine the current status of LCC implementation, and whether LCC management can be improved, the following investigative questions were posed:

1. What are the major LCC contributors and their potential for savings?
2. What is the timing of LCC emphasis?
3. When is LCC emphasis most effective in the acquisition process?
4. Is current guidance and direction adequate, and if not, what changes would improve LCC implementation?
5. What impediments exist to integrating LCC into the decision making process, and how can they be eliminated?
6. What impact did the models utilized on the programs reviewed have on program management actions?

## Definitions

For the purposes of this study the following terms are defined:

Life Cycle Cost (LCC): Blanchard offered the following definition:

> LCC involves all costs associated with the system life cycle, to include:
>
> 1. Research and development (R&D) cost--the cost of feasibility studies; system analyses; detail design and development, fabrication, assembly, and test ofengineering models; initial system test and evaluation; and associated documentation.
> 2. Production and construction cost--the cost of fabrication, assembly, and test of operational systems (production models); operation and maintenance of the production capability; and associated initial logistics support requirements

(e.g., test and support equipment development, spare/repair parts provisioning, technical data development, training, entry of items into the inventory, facility construction, etc.)

3. Operation and maintenance cost--the cost of sustaining operation, personnel and maintenance support, spare/repair parts and related inventories, test and support equipment maintenance, transportation and handling, facilities, modifications and technical data changes, etc. [for the purposes of this thesis O&S wil be taken to be effectively the same as O&M, although it is recognized that differences do exist].

4. System retirement and phaseout cost--the cost of phasing the system out of the inventory due to obsolescence or wearout, and subsequent equipment item recycling and reclamation as appropriate (Blanchard:19).

Life Cycle Costing: Robert M. Seldon defined life cycle costing as "The consideration of life cycle cost in choices or decisions among different courses of action" (Seldon:269).

R&M 2000: R&M 2000 is an initiative designed to change the fundamental way in which the Air Force approaches, considers, and manages reliability and maintainability (R&M). To effect required changes, R&M 2000 concentrates on key management objectives aimed at fostering senior level and Air Force commitment to R&M, convincing industry of the necessity of this commitment, and focusing manpower and program resources in an effort to institutionalize this commitment (R&M 2000 Action Plan:i).

## Limitations of the Study

The majority of the literature review and the data analyses focused on DoD and U.S. Air Force documentation,

regulations, plans, policies, and procedures. Other service data and guidance were discussed and reviewed with the intent of drawing from them methodology or procedures which could serve to improve the application of LCC management in the U.S. Air Force or DoD as a whole. This study presents an overview of some of the more commonly used LCC models and models being used on a trial basis but will not attempt to address the validity of particular models.

## Assumptions

One of the assumptions made in this research is that effective and efficient life cycle cost management is desirable and benefits DoD and the Air Force.

For the purposes of this research it was assumed that the programs reviewed, which were at the Aeronautical Systems Division (ASD) of the United States Air Force Systems Command, were representative of programs of similar size and complexity in other product divisions. In addition, life cycle costing techniques, implementation efforts, tools, modeling, and initiatives are assumed to be similar and comparable among the divisions.

## II. Literature Review

### History and Philosophy

In April 1976 Jacques S. Gansler, Deputy Assistant Secretary of Defense for Material Acquisition, said that the DoD recognized the need for increased readiness and reduced support costs, and that field reliability was the key. He stated that as a result of studies done three years before, which showed significant reliability problems, reliability had become "a major concern in the Defense Systems Acquisition Review Council process and an essential factor in the Design to Cost concept" (Gansler:1).

According to General Mullins, the mind-set that developed was that technologically advanced equipment was the answer, and that unreliability associated with this equipment was unavoidable or something that would be resolved later. Mullins noted that the knowledge of what causes parts breakdown and the technology to make many of the required changes exists; therefore, the problem is not that more cannot be done to reduce LCC, the problem is that people have trained themselves not to think about unreliability or the resulting LCC impact. He said the following with regard to this mind-set:

> This mind-set, more than anything else, is responsible for our designing and building systems that go fast and high, but not to do so reliably for any length of time. That mind-set is responsible for degradations we're now seeing in weapon system

> readiness and sustainability, and the tremendous amount of defense dollars we're now faced with allocating just to keep these systems going [Mullins:13].

Willis J. Willoughby, Deputy Chief of Naval Material for Reliability and Maintainability, suggested that, as opposed to being integrated with the design effort, milestones critical to LCC, such as the reliability demonstration, are often viewed as a "hurdle to be overcome by any means available other than fundamental design considerations" (Willoughby:13).

In the Air Force today it is generally felt that capability is measured in terms of performance factors such as speed, altitude and payload; while availability is measured in terms of logistics factors, such as reliability, maintainability, and supportability. The anonymous author of a recent article in Air Force Magazine indicates that what many have failed to realize is that the effectiveness of a weapon is a function of capability and availability. It is the combination of these two factors that determines the effectiveness of a weapon system (Acloggies:50). The author went on to say that while the Air Force has always been concerned with the availability of its weapon systems, the effort to modernize the force in the 1970s emphasized capabilities and numbers rather than availability. "Putting 'rubber on the ramp' was the first order of concern" (Acloggies:50). The author states that our focus had been on capability, and subsequent availability costs were largely ignored, and that Air Force

Systems Command (AFSC) has redefined its mission to that of delivering capable, supported weapon systems and that the goal is now:

> . . . to deploy a weapon system with everything required to achieve immediate operational readiness: maintenance procedures and trained maintenance technicians, a full complement of initial spares, sufficient support equipment, and so forth [Acloggies:50].

A categorical breakdown of the 1979 DoD budget showed the following cost distribution (in billions of dollars):

| | |
|---|---|
| CONSTRUCTION | $4.3 |
| RDT&E | $12.5 |
| PROCUREMENT | $32.2 |
| O&S | $77.0 |
| Total | $126.0 |

(Seldon:2)

This indicates that research, development, test and evaluation (RDT&E) and procurement represent approximately 35.4 percent of the total budget (Seldon:2). Current estimates and LCC modeling place RDT&E and procurement costs at 20 to 25 percent of total LCC.

General Mullins stated the following:

> Our strategy and tactics are built around the power of modern military technology. It follows, therefore, that to the extent the necessary technology can't be supported, our strategy and tactics must be called into question [Mullins:13].

This is illustrated by an example of the support requirements given by Willoughby for the aircraft carrier John F. Kennedy, which has 41,000 spares line items, costing in excess of $60 million dollars, just to support its aircraft. Willoughby states that given even the

shortest of confrontations the ability of our forces to sustain operations is in question, and that our failure to use LCC to develop cost effective systems capable of sustained operations is a serious flaw in our tactics which has still not been adequately addressed (Willoughby:13). Willoughby further stated that "combat engagements would quickly sever this 'umbilical to the beach'" (Willoughby:13).

Downstream LCCs for a system are having an increasing effect on funds available for new system development. The idea that Congress would increase the budget to allow for the increase in O&S costs has proven to be a grave mistake.

> Given the finite resources we have to work with, and the fact that our future defense needs will probably continue to outstrip the resources available to us, we must find an effective way to get more combat capability for the investment we're making [Mullins:12].

Guidance and Direction

LCC has been an issue for a number of years and it would seem that there is ample direction and guidance for implementing LCC considerations into the acquisition process.

According to Joseph D. Arcieri and Richard E. Biedenbender, in "An Updated MIL-STD-1388-1: Revitalizing Logistics Support Analysis", MIL-STD-1388-1, Logistics Support Analysis, serves as a guide for evaluating design trade offs, establishing support baselines, emphasizing support requirements, and making milestone decisions (Arcieri:8).

Department of Defense Directive (DoDD) 5000.1, Major System Acquisition, stipulates that:

> Improved readiness and sustainability are primary objectives of the acquisition process. Resources available to achieve readiness will receive the same emphasis as those required to achieve schedule or performance objectives. As a management precept, operational suitability of deployed weapon systems is an objective of equal importance with operational effectiveness [DoDD 5000.1:2].

DoDD 5000.1 also states:

> A cost effective balance must be achieved among research, development, production, and ownership costs of major systems, and system effectiveness in terms of the mission to be performed [DoDD 5000.1:2].

DoDD 5000.1 states that opportunities to significantly reduce DoD ownership costs may result in system acquisitions. It states that depending on the degree of program risk involved, we should provide early funding to allow for the designing-in of reliability and support. DoDD 5000.1:3-6) It specifies that "logistics supportability shall be considered early in the formulation of the acquisition strategy and its implementation" (DoDD 5000.1:7).

DoDD 5000.1 also states that the System Concept Paper (SCP) "provides basic documentation for use by the DSARC members in arriving at a recommendation to the Secretary of Defense", and will do the following:

> . . . identify program alternatives based upon initial studies and analyses or design concepts; alternative acquisition strategies; expected operational capabilities; industrial base capacity; readiness, support, and personnel requirements; and cost estimates [DoDD 5000.1:7].

The Assistant Secretary of Defense (Acquisition and Logistics) is given responsibility for "policy, review, and acquisition strategy for the production procurement of all systems" and for logistics policy relating to facilities, energy, and the environment (DoDD 5000.1:10). DoDD 5000.1 also states that the Director, Operational Test and Evaluation (DOT&E) shall "evaluate cost-effectiveness studies prepared in support of milestone decisions for major system acquisitions" (DoDD 5000.1:11).

Department of Defense Instruction (DoDI) 5000.2 Major System Acquisition Procedures implements DoDD 5000.1 and directs that: LCC be considered for major systems in the Justification for Major System New Start (JMSNS) and that readiness, sustainability, and manpower be addressed in the System Concept Paper (SCP) and the Decision Coordinating Paper (DCP) (DoDI 5000.2:2,2-1,3-1, 4-1). DoDI 5000.2 states that the Integrated Program Summary (IPS) will:

> . . . show areas where projected or potential facilities, manufacturing technology, industrial modernization improvements, producibility program, or utilization of standard components and subsystems would reduce production costs significantly [DoDI 5000.2:5-2].

Two of the purposes of DoDD 5000.39 Acquisition and Management of Integrated Logistics Support for Systems and Logistics are to establish "the requirement for life-cycle management of major system ILS" and to provide "guidance when establishing ILS policy for less-than-major systems

and equipment. The following is a list of specific sections under DoDD 5000.39 and considerations under those sections which have a direct impact on LCC.

The management support requirements section of DoDD 5000.39 specifies that:

> . . . O&S cost data shall be incorporated in DoD component visibility and management of O&S cost information systems and made available to developers of new systems at the level of detail needed for use in design trade offs [DoDD 5000.39:4].

The Under Secretary of Defense for Research and Engineering is required to ensure that a proper balance exist between cost, schedule, performance and supportability (DoDD 5000.39:6).

Enclosure 4 of DoDD 5000.39 is "Program Manager ILS Responsibilities" and includes the following statement:

> As a normal course of action, source selection criteria and contract performance clauses shall be used to provide contractors the incentive to deliver systems that meet R&M and support objectives. Source selection evaluation criteria for appropriate competitive programs shall include a separate evaluation factor (separate from schedule, cost, and performance) for readiness and support, weighted to ensure a positive effect on contractor selection and contract award [DoDD 5000.39:4-1].

Air Force Regulation 800-8, Integrated Logistics Support (ILS) Program, states "policy for implementing and managing an ILS program, and defines requirements for applying ILS throughout the lifecycle of new systems" and has as its objective "to field weapon systems and equipment that achieve the required readiness and sustainability posture at an affordable life cycle cost" (AFR 800-8:1). AFR 800-8 requires that "plans are

established which ensure application of LCC disciplines throughout the acquisition process" (AFR 800-8:15).

R&M 2000 emphasized the following objectives:

1. Provide clear direction for R&M policy to increase system combat effectiveness and supportability.

2. Establish an organizational structure designed to focus on R&M and increase R&M expertise, advocacy, authority, and accountability.

3. Establish consolidated R&M planning among commands, and tie R&M to operational goals.

4. Establish accountability, review, and feedback to measure progress in the R&M improvement program

5. Provide the communication and motivation needed to maintain organizational support for the R&M program.

6. Ensure contractors are motivated and capable in the area of R&M, and obtain industry commitment and support of the R&M requirements (R&M 2000:i).

LCC Drivers

Reliability and Maintainability. The majority of efforts to reduce O&M costs center around attempts to increase the reliability and maintainability of systems. This is because R&M are the major determinants of manpower, spares, support equipment and costs associated with O&M, and similarly LCC. General Mullins commented:

> . . . the single greatest limitation to our having the combat capability we need today is logistics. That's why the single greatest impediment to our having the kind of logistically supportable systems we must have is the lack of system reliability. That's why our real leverage in generating combat capability comes first and foremost in the area of reliability improvement . . . The up-front cost of making this kind of investment in reliability would be high . . . the return in future cost savings alone would stagger the imagination,

especially when one considers that we now keep our weapon systems for 20 to 30 years [Mullins:15].

He noted that the true measure of merit of weapon systems is not how good they look on the ramp or how high or how fast they can fly, but how reliably they can perform their wartime mission and that aircraft effectiveness would be equated to "damage expectancy" (Mullins:14). He said that damage expectancy was determined by launch success, weapon system reliability, probability of penetration, and probability of kill. With the probability of launch success and target penetration around the 98th percentile, and the employment of state-of-the-art munitions and smart bombs which have dramatically increased the probability of kill, we have successfully dealt with all factors except reliability (Mullins:14). He gave an example of how significant savings could be achieved, thus reducing the LCC of a system:

> For a 25 percent improvement in MTBF, perhaps from 500 hours to 625 hours, you could reduce the spares requirement almost 40 percent and still maintain the same aircraft availability. If you could double the present MTBF, you would eliminate almost 80 percent of the present spares requirement [Mullins:16].

According to Robert N. Parker, Principal Deputy Director for Defense Research and Engineering, DoD began efforts prior to April 1986 to:

> . . . establish a uniform set of reliability terms and definitions that can be tracked from the initial statement of an operational requirement, through all phases of research and development, and test and evaluation, to field service. A key

> initiative is the distinction between reliability as a factor in successful mission completion, and malfunctions that drive ownership cost. The recognition of this distinction will allow better cost/effectiveness trade offs [Parker:19].

Robert F. Trimble, Assistant Administrator for Contract Administration, Executive Office of the President, observed that "the technology for reliability was more easily obtainable than the basic technology of the equipment itself" (Trimble:5); but that emphasis has been on product design and development and money intended for reliability has been used for other uses, and that the Government has paid little attention to ownership costs resulting in the victimization of reliability (Trimble:20-21). According to the article "Acloggies":

> The challenge in reliability is to decrease the amount of down-time or maintenance required to keep the weapon system operational. Maintainability of the weapon system includes designing in ease of maintenance-to preclude, for example, situations where it takes much longer to gain access to a part that wears quickly than it takes to repair or replace it. Designing supportability into systems means such things that can reduce support requirements as using common connectors for fuel, ground equipment, and external stores [Acloggies:50].

Gansler maintained that we are learning to develop systems that are reliable in the field, and this development process is systematic in that it involves many areas which interact and impact on reliability. First, we must be aware of the fact that reliability measurements achieved in the laboratory environment do not necessarily represent what we would expect to achieve in the field. Second, the time to emphasize reliability is during system

development. The flexibility to make trade offs against performance characteristics which would significantly effect reliability needs to exist. Finally, we have to start looking at reliability as a product of the system as a whole, versus just a function of system reliability design parameters: "logistic support elements, testability, and all other system attributes must be considered in the acquisition planning" (Gansler:1).

Gansler stated that for the second consideration to be possible funding and scheduling must be geared towards design flexibility (Gansler:1).

Actual versus Predicted. Parker held that actual field reliability is often much lower than that predicted or demonstrated in the laboratory.

> This has led to optimistic projections of operational effectiveness and ownership cost. It can also lead managers down a "primrose path" during development, since predictions and demonstrations indicate that reliability requirements are being met. In point of fact, the opposite is the case [Parker:19].

Anthony J. Feduccia, Chief, Systems reliability and Engineering Branch, Rome Air Development Center (RADC), discussed the importance of establishing clear and consistent R&M requirements. He stated that the the decisions which dictate the R&M requirements are in reality established prior to system design by users or staffers, and that in many instances the requirements do not reflect a consciousness of R&M or its implications. Some of the problems encountered included the definition of failure,

the manner in which hardware failures were counted (and if they differed from reliability predictions), how to include software errors, and in deciding which system errors the requirement applied to (Feduccia:25-26).

In the example given below, clear definitions of terms, meanings, and requirements were given. The 150-hour mean time between failure (MTBF) requirement is representative of one which might be listed in a program management directive (PMD). Feduccia shows how the 150-hour MTBF is satisfied yet the system only operates 75 hours at a time. Data was collected for a system with a total of 1,740,000 operating hours and a summary of the results is given below:

> A total of 23,193 maintenance actions were logged during this period resulting in a mean time between maintenance actions (MTBMA) of 75 hours. This is the real world number; this is the 'reliability' the user is living with every day . . . But the developer looks at the situation differently . . . the actual failures (hardware only) logged were 10,431; thus the MTBF of the system is 167 hours, surpassing the requirement. The confusion stems from the fact that, of the 23,193 total maintenance actions, 2,188 were found to be no defect (no identifiable reason for the outage); 2,966 were removed to facilitate other maintenance (RTFOM) (not failures); 4,911 were actually caused by other on-aircraft maintenance actions; and 13,128 were actually labelled as failures. However, of the 13,128 failures, 900 were induced and, of the remainder, 1,797 were solved by adjustments. That leaves only 10,431 considered as relevant failures, resulting in the 167-hour MTBF [Feduccia:25-26].

He listed the major reasons for differences between predicted and actual reliability as:

1. False removals
2. Different definitions of failure

3. Maintenance-induced failures

4. Environment

5. Configuration changes to the original equipment

6. Spare parts (Feduccia:26)

Commercial Off-the-Shelf Equipment. Feduccia noted that:

> Program management directives and other DOD/USAF documentation require program planners to consider using existing military hardware . . . and to make extensive use of applicable commercial off-the-shelf equipment [Feduccia:26].

Feduccia warned that there are certain inherent risks involve in the indiscriminate application of off-the-shelf equipment and that the operational factors that may be affected must be considered. He recommended that a risk assessment should be used to determine whether the LCC savings outweigh the associated risk. In a RADC-sponsored study he discussed the most important operational factors are identified and weighed according to the importance to success (Feduccia:26-27).

Parts Selection and Control. Extensive usage of piece parts can effectively lock the Air Force to an individual supplier and his prices, "and could cripple the operational readiness of a system if the supplier decides to abandon that particular product line" (Feduccia:27).

Feduccia believed that since it is seldom possible to avoid the use of such piece parts that the program manager should establish strong Parts Control Boards or Parts Advisory Groups to review the contractor's initial parts

list, and that "approximately 90% to 95% of the electronics of a typical Air Force system can be handled with known technology or military-approved parts" (Feduccia:27). Feduccia provided a list of government parts specialists available to the program manager which is summarized below:

1. Military Parts Control Advisory Group (MPCAG) (for electrical and electronic parts)
2. Defense Industrial Supply Center (for mechanical parts)
3. RADC's microcircuit reliability assessment program (MRAP) and semiconductor reliability assessment program (SRAP) (Feduccia:27)

Derating. Feduccia defined the practice of derating as:

> . . . reducing the electrical, mechanical, or environmental operating stresses below the maximum levels the part is capable of sustaining. It can be applied to electrical, mechanical, or electromechanical parts, in each case resulting in increased lifetime for the particular part [Feduccia:28].

Feduccia contended that decreasing these stresses to below the maximum levels can result in a significant increase in the reliability of the system, and that by being conservative in design approach and properly incorporating the derating of parts that a safety margin for device inspection and testing and unforeseen anomalies would be created (Feduccia:28).

Willoughby stated that:

> Once the environmental specifications have been established, the selection and application of parts and materials then become critical and play a significant role in reliability achievement. Therefore, a vigorous parts program is essential to establish and maintain through organizational policy

> qualified parts lists, specification control drawings for parts procurements from approved sources, and laboratory facilities for testing and screening of parts and materials which assure that electrical, mechanical, and thermal stresses on the product's parts are substantially below their design limits [Willoughby:16].

Willoughby said that "military procurements seldom invoke specific derating requirements, or often take notice of contractor policies at design reviews" (Willoughby:16). Willoughby also stated the following:

> Adequate derating often yields reliable products using inexpensive, widely available parts, while even the best parts will fail repeatedly if derating is inadequate. For example, in the rapidly escalating use of solid state electronic devices, including large-scale integrated circuits, a reduction of 10 degrees Centigrade in the junction temperature (about 5 percent of the maximum rating) below 70 degrees Centigrade has been found to double the reliability of the device [Willoughby:16].

In reference to derating guidance Feduccia said the following:

> The AFSC policy on derating directs the inclusion of proven derating requirements for all classes of devices and requires verification by analyses and measurement. The policy is mandatory for all advanced and full-scale development programs and is strongly recommended for incorporation into current contracts [Feduccia:28].

Feduccia pointed out that "there is no recognized standard for derating and there is not a large amount of published literature on derating methods or practices" (Feduccia:28). He indicated that a RADC document, RADC TR 82-177, Reliability Parts Derating Guidelines, allows the Air Force a means of comparing a contractor's derating criteria with that obtained from a variety of military and industrial sources (Feduccia:28).

Maintainability/Testability. According to Seldon:

> The maintainability characteristics of a design, set during the development phase, are second only to reliability features in driving costs of the O&S phase [Seldon:212].

In discussing testability Seldon noted that, "as is true for reliability, the designer establishes maintainability and can change it" due to the fact that it is both measureable and controllable (Seldon:212-216). He observed that test equipment, whether built-in or separate, can reduce this cost of maintaining equipment and in fact have become commonplace in the development of complex systems. He observed that, although test equipment often represents 10 to 20 percent of the total acquisition cost, the time and manpower saved by simplifying maintenance may more than justify the expense of the test equipment (Seldon:217-219).

Blanchard noted that maintainability was a "design characteristic dealing with the ease, accuracy, safety, and economy in the performance of maintenance functions" (Blanchard:32).

Feduccia stated the purpose of a maintainability program as follows:

> . . . to improve the availability or operational readiness of a system, reduce its maintenance manpower requirements, and minimize its life cycle costs [Feduccia:28].

Feduccia stated that a subset of maintainability is equipment/system testability which is the ability to detect and locate failures.

> It impacts both the time and maintenance duration needed for fault detection and fault isolation (FD/FI) activities which usually consume more time and resources than all other corrective maintenance actions combined [Feduccia:28].

He also stated that commitment to maintainability/testability requirements would produce:

1. Testability requirements based on operational requirements
2. Designing for an optimum mix of built-in-test (BIT) and external test equipment (ETE)
3. The identification of testability responsibilities and focal points (Feduccia:28-29)

Feduccia provided the chart displayed in Figure 1 in order to demonstrate the cost effectiveness and utility of testability. A summary of the information given in Figure 1 is as follows:

> As fault detection requirements increase, the testability cost savings also increase. At 94% fault detection, the cost savings between the two designs are significant. At 95%, only the PCB [printed circuit board]designed for testability meets the requirement. Also, the testable PCB requires fewer test patterns and less testing time. The board designed without testability required 4,590 test patterns and 78 seconds to detect 92.2% of all possible faults. The board redesigned for testability required 1,449 test patterns and 28 seconds to detect 100% of all possible faults [Feduccia:29].

Willoughby held that the purpose of testing was "to ensure that the design meets all stated performance specifications, including the reliability requirements" (Willoughby:17), and that:

> . . . only if the factory test conditions duplicate or exceed the field environment will the testing be truly effective in ensuring that specified performance and reliability requirements will be met after deployment [Willoughby:17].

TESTABILITY COST SAVINGS

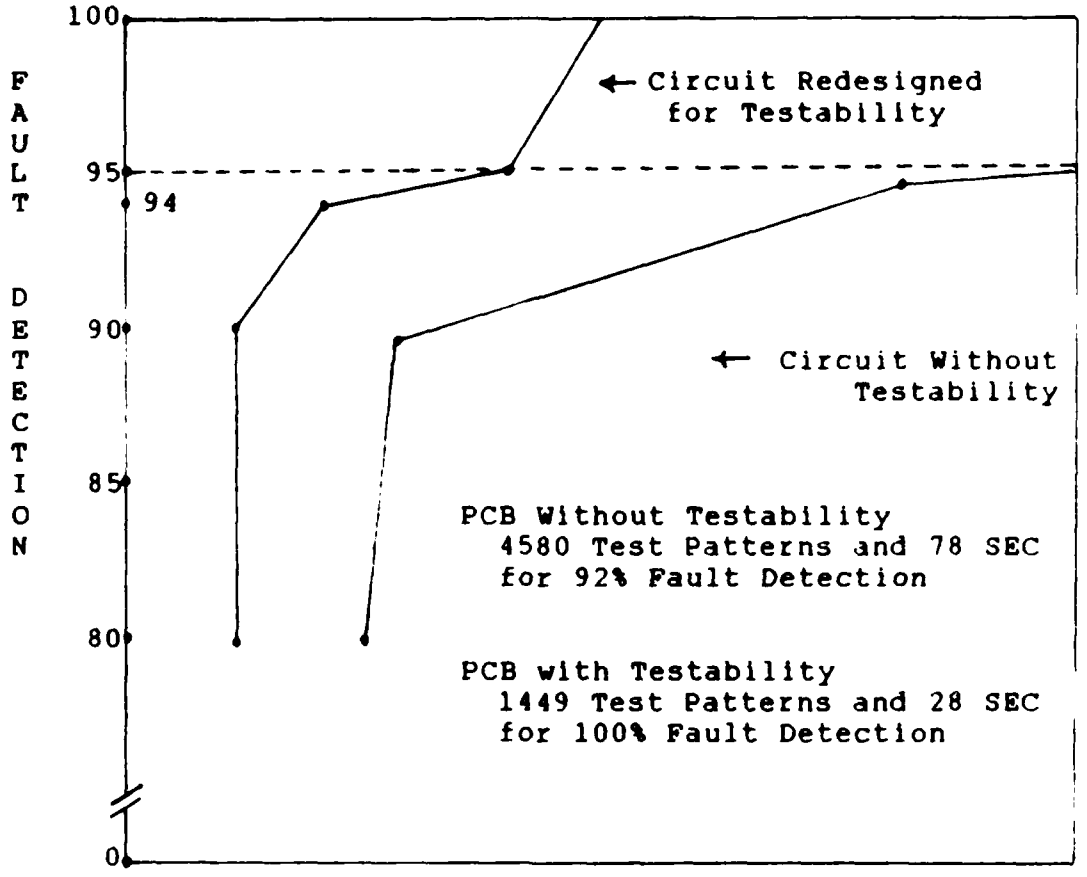


Fig 1. Cost-to-Test of a Printed Circuit Board

(Feduccia:29)

Willoughby said that three major factors which influence the appropriateness of testing were an environmental profile that fit the mission, an integrated test plan which sets up a logical progressive sequence of

testing, and "operational test and evaluation by the Government to give the product its first exposure to real mission environment" (Willoughby:17).

Willoughby concluded that for reliable systems to be acquired management must realize that highly reliable weapon systems can be effective and less costly, and that reliability must be made equal to or more important than performance. He stated that engineering design and quality assurance must be clearly stated in order that results could be measurable and manageable, and strict enforcement of LCC principles was essential (Willoughby:18).

LCC Timing

According to Wade, the Assistant Secretary of Defense (Acquisition and Logistics), emphasis on LCC should be at the earliest possible stage of system development. The cost to implement R&M enhancements becomes ever more expensive as a system progresses through the acquisition cycle, resulting in reactive and costly logistics functions. The problem is, however, that "By the time logisticians become involved in most weapon system acquisitions, it is too late and too costly to alter the basic design" (Wade:5). Wade contended the following:

> More than half of the total life cycle costs of any weapon system are logistics costs, and we commit the bulk of these expenditures in the concept definition and development stages. There is thus an urgent need for early involvement and integration of logistics engineers into the development process. Only then can they help shape maintenance and support concepts still being formulated [Wade:3].

Willoughby stressed the importance of designing in reliability starting in the conceptual phase, and that "field retrofit to correct poor design is the most expensive and disruptive approach to reliability improvement" (Willoughby:16). He emphasized the need to address reliability needs in the systems envisioned to meet operational requirements because "the basic concept often 'locks in' the inherent upper limits of reliability at levels which will clearly be unable to meet future operational needs in the field" (Willoughby:15).

Webster's weapon system life cycle cost curve given in Figure 2 demonstrates "that logisticians can ill afford to relax during the early development phase of a new system or they will miss the chance to influence design" (Webster:5).

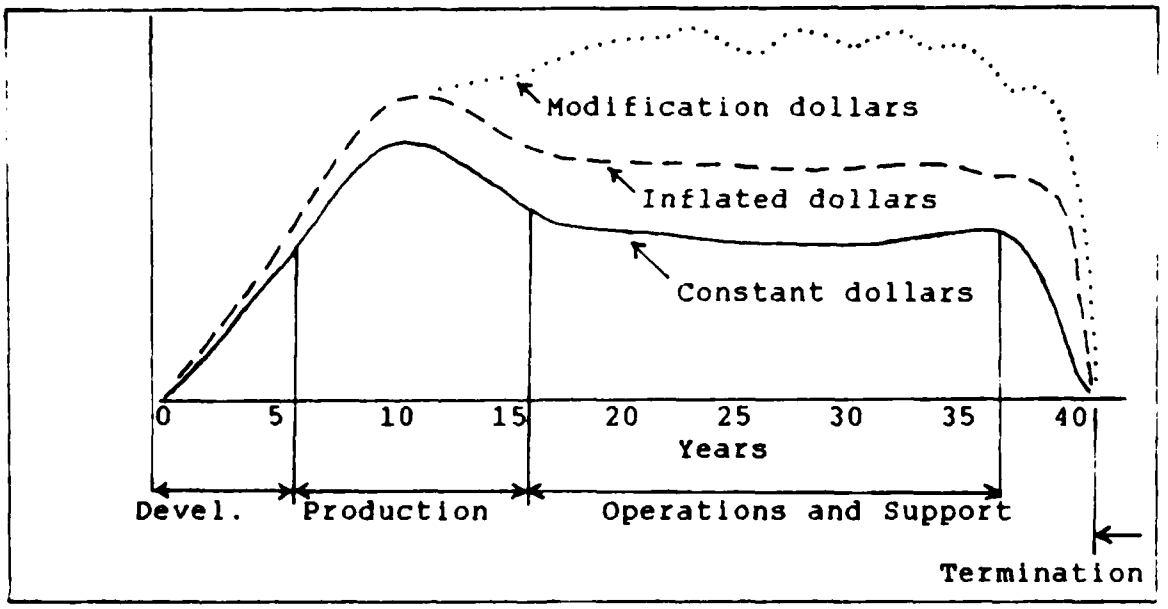


Figure 2. A Symbolic Representation of Program Annual Life Cycle Expenditures for a Major Weapon System

(Webster:5)

Webster stated that "what progress has been made in recent years stems from logisticians doing their homework and speaking out early in a system's life" (Webster:5).

Lieutenant General Marc C. Reynolds, Vice Commander, Air Force Logistics Command, stated that by the end of the requirement validation phase approximately 80 percent of the life cycle costs have been committed. Committed, in this sense, implies that decisions which would impact LCC have been made. A December 1984 Air Force Acquisition Logistics Center study showed that 70 percent of the key weapon system decisions have been made by the end of conceptual studies, 85 percent of the decisions defining LCC are made by the end of system design definition, and 95 percent of the decisions affecting LCC have been made by full-scale development (Reynolds, Lt Gen Marc C.:3).

The exclusion of logistics management in the development phases and "the lack of diagnostics and prognostics in weapon system design has resulted in operational logistics functions that are reactive and costly" (Wade:5). Exclusion of logistics management is generally recognized to have the effect of increasing LCC.

Modeling

According to Seldon, one of the major problems with modeling is that acquisition costs are apparent and fairly easy to quantify while O&S costs are not. Systems O&S costs are spread out in such a fashion that easy

identification and association with a particular system are difficult. This has allowed the problem to persist as long as it has and makes it difficult to place responsibility or emphasis where needed. The analyses of LCC is called life cycle cost analyses (LCCA) and is most commonly accomplished using modeling (Seldon:15-16).

The most popular LCC estimating procedures include analogies, cost estimating relations (CERs), and industrial engineering cost estimates. Analogies are comparisons based on similar programs, where the data is adjusted for differences that might exist. Cost estimating relations use generalized relationship which are developed between program characteristics and the cost. Industrial engineering cost estimates require that costs be developed for individual parts and then combined (Seldon:15-16).

According to Mark S. Schankman, a senior engineer in the logistics engineering department of McDonnell Douglas Astronautics Company, while computer simulation models and analyses are useful, they are time consuming to write, costly to run, and do not provide adequate visibility of the effects of individual components; additionally, they often prove unable to accurately predict actual results. Faced with this problem on the Navy's F/A-18 fighter aircraft development, a new analytical tool, the "logistics elements alternatives", was developed, and proved adaptable to other weapon systems as well. Schankman asserted that this model employed only the key elements mean time between

demands, turnaround time, spare parts procurement, and beyond capability of maintenance, thus allowing for easy collection of data and run costs of less than ten dollars, while providing results far better than those of previous models. Schankman states that an important aspect of model utility is its potential to predict support deficiencies, cost-reduction opportunities, and formulate corrective actions. He said that the timeliness afforded by the model allowed for an iteration to be run "in a matter of days, compared to months for large-scale simulation models" (Schankman:33-39). Schankman stressed the importance of the accuracy of the field data for R&M. He observed that:

> Because of design changes and other factors, past performance may not be indicative of the future. Consequently, a dedicated field data collection and analyses effort is essential if the model is to yield valid support evaluation predictions [Schankman:39-40].

James H. Green, writing in Logistics Spectrum, gave an several examples of how simplified spreadsheet models, using personal computer programs such a LOTUS 1-2-3 and Symphony, have provided accurate results. He gave two major advantages to using spreadsheets for life-cycle analyses. First, products can be easily compared once a template has been constructed, and second, "you can perform sensitivity analyses on any factor influencing the purchase decision" (Green:34).

Troy V. Cavers, writing in Program Manager, said the Cost and Strategy Assessment (CASA) model was developed for

government life cycle costing and can be run on a personnel computer with a hard disk and a minimum capacity of 320 kilo-bytes internal operating memory. He stated that in addition to life cycle costing the model is also capable of examining acquisition costs with varying production rates and quantities, while considering inflation; accomplish sensitivity analyses with reliability, maintainability, and unit cost as variables; and doing comparative analyses of competing alternatives in source-selection. He stated that, when tested, it was demonstrated that the model could be applied to a number of contracts. On these tests CASA saved anywhere from fifty thousand dollars to four hundred thousand dollars per contract, and at the same time allowed for a better design trade off that would save additional dollars downstream (Caver:50). Some of the capabilities include the ability to determine the cost effectiveness of the warranty, support equipment utilization, R&M impact on LCC, maximum operational availability, and to be able to provide comparative analyses of competing systems (Caver:50-51).

Caver also discussed the fact that although adequate policy exists concerning life cycle costing, there is still widespread belief among program managers that models are not available or appropriate (Caver:51). In an example cited, the two week task of data development and entry was reduced to 11 hours by using CASA. Proprietary restrictions have been removed to allow for CASA to be used

on government contracts, and it is claimed to be fairly simple to learn and operate (Caver:51).

Implementing LCC

Air Force Systems Command and Air Force Logistics Command (AFLC) have been working together to solve many of the problems with system acquisition that result in higher LCC costs. In the article "Acloggies" one of the AFSC/AFLC initiatives discussed is that of addressing logistics concerns early in the acquisition process. A Deputy Chief of Staff for Acquisition Logistics was established at the headquarters and at each product division in order to assure that LCC was addressed early (Acloggies:50). The intent was to ensure that logistics elements, and thus LCC determinants, were addressed from the design to the deployment of a system. One of the main methods of implementation was to be that of conducting periodic logistics readiness reviews. Other initiatives discussed were organizational changes which included the establishment of the Air Force Acquisition Logistics Center for the purpose of providing technical expertise on acquisition logistics issues (Acloggies:50).

Implementation of R&M and LCC considerations is generally considered most effective when done in early program stages. Willoughby stated that reliability requirements should be specified in the Operational Requirement (OR) and the Decision Coordinating Paper (DCP). He asserted that there was a difficulty in accomplishing

this prior to concept validation it is a necessary step to getting "the attention it demands at the higher defense management echelons" (Willoughby:14). Willoughby emphasized that:

> With the current emphasis on maximum combat effectiveness at minimum life cycle costs, it must be made clear that both of these parameters become frozen once firm reliability requirements are specified, and are never considered unless meaningfully enforced. It is essential that setting reliability levels in the OR and DCP become a concern of top management to the same extent as performance levels, instead of leaving the task to the project manager and the contractor [Willoughby:14].

Willoughby quoted General Samuel C. Phillips, former Apollo Program Director and former commander of the Air Force Systems Command, as stating that "a designer may make reliability his initial consideration and then look for alternate approaches to achieving performance . . . " and that these more reliable systems will cost more to procure; however, he felt that the increase in procurement cost will be balanced by the reduction of O&S costs in the field (Willoughby:15).

Trimble felt that motivating the contractor in this fashion is possible but may achieve less than optimum results if the side effects are not considered. In many cases "improvement of reliability can be counter to a manufacturer's financial interests in terms of reduced spare parts sales", and "arrangements need to be made to provide the manufacturer with a stake in the O&S costs of the equipment" (Trimble:22-23).

Parker stated that provisions were added on the F-16 fire control radar development contract to allow for reliability improvement testing. He said that these provisions were designed in such a fashion as to motivate the contractor to accept a production reliability improvement warranty (Parker:19).

Parker stated that, in the case of the F/A-18 fighter, a large percentage of the development contract fee was linked to the successful demonstration of reliability (Parker:19). Feduccia stated that the F/A-18 fighter, when compared to the F-4, had 8,000 fewer radar parts and 7,700 fewer engine parts. Feduccia said that this resulted in a fifty percent reduction in maintenance man-hours per flight hour, and more than a twenty percent reduction in O&S (Feduccia:29).

Caution should be taken to ensure that the warranty clause utilized is appropriate, and the R&M measures used must be applicable to the real world environment (Gansler:1). Gansler stated that:

> . . . the demonstrated reliability does not project failures normally encountered in the field, such as those caused by maintenance error or by another system. But in the field all the failures count. Therefore, we must plan our programs by relating test and design goals to the end objective--desired field reliability [Gansler:1].

According to Wade, the establishment of a defense acquisition corps would allow us to meet the complex challenges of defense acquisition management, to improve the DoD acquisition organization structure, and provide the

program manager access to senior acquisition executives with decision authority, and resource control. He felt that by providing for the movement of funds, people, and information we could "attack causes rather than symptoms", resulting in reduced LCC and improved readiness. (Wade:29)

To meet these objectives he felt that several things needed to occur. First, the management structure needed to be modified in order to allow the switching of funds between different logistics elements. Second, costing techniques need to be developed for evaluating high cost and usage items, and for making required trade offs. Third, logisticians require authority and resources equal to that of other responsibility centers. Finally, senior logisticians should be experienced in at least two fields of logistics (Wade:4).

He also said that those responsible for ensuring logistics supportability was addressed did not have the resources, flexibility, or equal status in the project hierarchy required to accomplish their job effectively (Wade:5-6).

Contract Methodology. Trimble discussed a cradle-to-grave acquisition strategy which considers design principles which will improve system reliability and reduce LCC, which involves heavy emphasis on reliability at each contractual phase (Trimble:21). He stipulated that:

1. Early emphasis on reliability cannot be over stressed, and requests for design proposals should emphasize reliability.

2. During concept validation competing prototypes can be developed and reliability determined. In order for this to be possible all factors used in the evaluation and selection process must be provided.

3. If no competition exists, award fee-type contracts can be used to motivate contractors to enhance reliability.

4. In cases where unit or program costs are low competition can be extended into the full-scale development phase allowing for tests under actual field conditions.

5. Improvements can continue through full-scale development and production by providing proper incentives for the early completion of successful testing; and by continuing to stress trade off studies (Trimble:21-22).

U.S. Office of Management and Budget (OMB) Circular NO. A-109, Major Systems Acquisition, stipulates that:

> Contractors should be provided with operational test conditions, mission performance criteria, and life cycle cost factors that will be used by the agency in the evaluation and selection of the system(s) for full-scale development and production [Circular NO. A-109:9].

Willoughby discussed an approach to contracting methodology which recognizes that applying life cycle cost studies is often complicated by the unavailability of needed support cost data. This approach addresses acquisition cost as a function of reliability:

> Since acquisition costs are in the real-time domain of the contractor, it may become necessary to request proposals for a range of reliability alternatives, in order to support life cycle cost analyses prior to source selection [Willoughby:14].

Another concept discussed was that of the Reliability Improvement Warranty (RIW) concept. Trimble noted that RIW implies that:

> . . . repair or replacement of failed units should be conducted for a prescribed period of time during production at the manufacturer's own facilities. The agreed-upon contractual price for this activity is carefully related to reliability performance predictions based of tests conducted in earlier phases of the acquisition process. If the equipment fails to preform as predicted, the manufacturer must underwrite the added expense of repair or replacement. On a more positive note, performance exceeding established contractual levels result in added profit to the manufacturer; thus, the contractor has an incentive to identify and correct design deficiencies [Trimble:23].

Commodore Stuart Platt, the Competition Advocate General of the Navy, contended that "logic dictates that life-cycle cost must be considered in choosing between alternatives" in source selection; and that, with regard to the perceived difficulty of doing so, two things will make the analyses easier to manage. First, just the costs that differ between the alternatives need to be considered. Second, relative versus actual costs can be estimated for parts of the analyses (Platt:44).

Initiatives. Many efforts to increase weapon system availability are currently underway and would have the effect of lowering LCC if properly implemented. Some of these initiative include "the use of form, fit, and function criteria for ease of maintenance and integration of new test and diagnostics capabilities like the successful Modular Automatic Test Equipment program, which also speeds up maintenance" (Acloggies:50).

Webster stated that LCC could be reduced by the addressing of logistics concerns through the Defense Acquisition Board (DAB), and that participating in that

process would facilitate the implementation of former Deputy Secretary of Defense Frank Carlucci's initiatives dealing with support and readiness (Webster:6). These initiatives are describe as follows:

1. Achieve support and readiness by setting readiness objectives early in the acquisition process.

2. Provide front-end funding for test hardware, and structure acquisition programs to include adequate development and test assets.

3. Provide contractor incentives for reliability and support by developing incentivizing strategies; design and support of planning approaches to minimize support risk.

4. Use standard operational and support systems in order to reduce support costs and risks.

5. Provide Program manager control of logistics and support resources to allow for the support of weapon system readiness requirements in the planning, programming, and budgeting process (Webster:7).

Colonel John C. Reynolds and Major Fred G. Saliba, Director and Chief of Plans and Programs Division, Air Force Coordinating Office for Logistics Research, discussed another LCC initiative. This initiative is intended to emphasize logistics concerns and reduce life cycle costs through the establishment of two new program elements who will "provide management structure for dealing with reliability, maintainability, design, and support concept technology which spans two or more laboratories" (Reynolds & Saliba:3). They stated that:

> In addition to influencing the Air Force laboratories to increase their levels of defined logistics/supportability oriented research, management will place additional attention on

communicating supportability requirements to industry through Statements of Work (SOWs), Statements of Need (SONs), Justification for Major System New Starts (JMSNSs), and Request for Proposals/Quotations (RFPs/RFQs) [Reynolds & Saliba:3].

Summary of the Literature Review

LCC trade offs have been poorly utilized. Budget tightening, rapid technological changes, and congressional and public awareness of inabilities to maintain the kind of combat capabilities desired force us to look at the long term implications of systems currently being fielded. In summary:

1. Realistic budget estimates will depend on the accurate determination of LCC.
2. Acquisition costs represent only a small portion of LCC.
3. Capabilities must be viewed in terms of availability as well as performance.
4. R&M is the major contributor to O&S costs and LCC.
5. R&M 2000 recognized serious short falls in the awareness of the importance of R&M and savings in LCC; and that cost, schedule, and performance are still given higher priority.
6. Added emphasis should be given to maintaining the momentum that has developed.
7. Use of warranties and contractor incentives should be expanded to promote a continual effort to reduce LCC.
8. The Reliability Improvement Warranty (RIW) has proven effective if managed properly; the incorporation of incentives must be tied to realistic goals.
9. Reliability should be measured in terms of real world performance.
10. LCC should be given equal consideration to other selection criteria in all phases of system

development and should be a significant factor in determining contract award; however, maximum LCC savings can be realized in early stages of system development.

11. Many models are complex, expensive, and inaccurate; consideration of less complex yet more accurate modeling capabilities and of personal computers is recommended by numerous authors.

# III. Methodology

## Overview

This chapter describes the process through which the investigative questions in Chapter I were answered. To answer the investigative questions, a data collection and organizational system developed by Cira and Jennings in their thesis Life Cycle Costing: A Working Level Approach (Cira and Jennings:10) was adapted for use. Figure 3 depicts the method of data collection and incorporation and the criteria used to determine issues or processes to be included in the data analyses in Chapter IV.

## Problem Orientation

The investigative questions listed in Chapter I were answered as follows:

1. Magazines, periodicals, and professional journals were examined to determine LCC drivers in order to establish the types of changes which could result in the largest potential for savings.

2. Government regulations and directives were reviewed to determine how and when life cycle costing is applied.

3. Government regulations and directives were reviewed to determine the status of managerial focus and implementation authority.

4. Informal interviews were conducted with Aeronautical Systems Division (ASD) personnel to determine what impediments exist to integrating LCC into the decision making process and how they might be overcome.

5. Literature and government documentation was reviewed to determine which LCC models where being used, and to determine if improvements were needed.

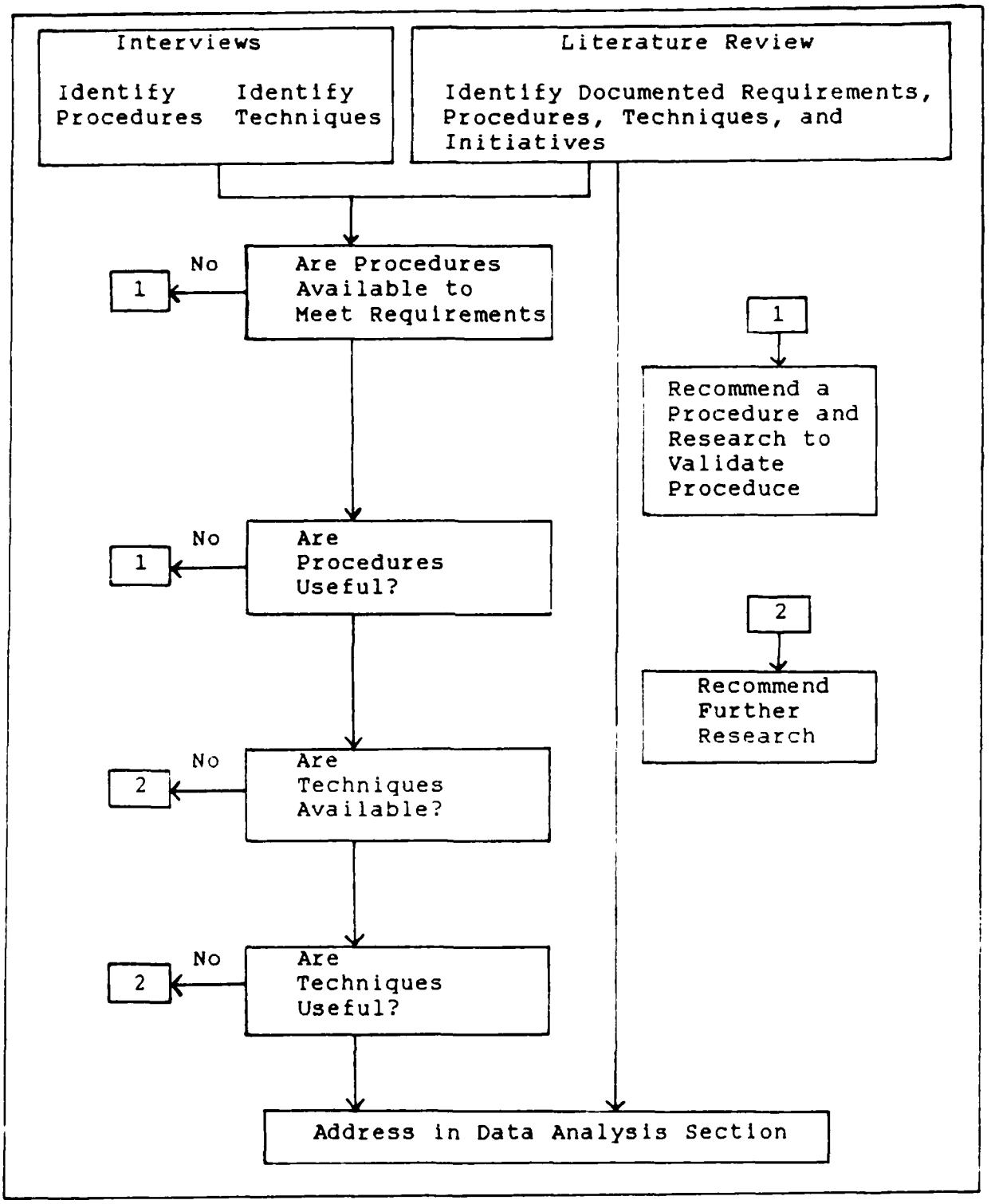


Fig 3. Thesis Logic Process

## Document Review

The document review portion of the research effort entailed a review of existing Government documentation to include DoD, and U.S. Air Force directives, policy, regulations, and guidance. This literature review was expanded and supplemented by current journal and periodical articles pertaining to LCC. The intent of this review was to develop a perspective on the current status of LCC, and the potential to improve its effectiveness. The first step was to break out the various components of LCC which deserved further investigation. This break out allowed each component of LCC to be evaluated on its own merit, and to facilitate the presentation of possible changes in timing, application, modeling used, and implementation. The second step evaluated the process as a whole in order to determine what technique, process, or overall guidance and direction would be appropriate.

## Interviews

The interviews followed the literature review to allow for a more thorough understanding of the current status of LCC, and in order that questions could be generated which would address areas of particular concern. The interviews served two purposes:

1. One of the purposes was to draw upon the experience of individuals involved in system acquisition at ASD.

2. A second purpose was to obtain data from primary sources on the application of LCC management to current programs.

The inputs of these individuals were analyzed in the data analyses section of this research. Four steps were used in preparing for the interviews.

1. The questions to be asked were determined.

The investigative questions listed in Chapter I served as the basis for the interview questions. They were adapted to determine the particular program efforts and status for each area of concern. The interview was designed to be informal in nature, and the questions were designed to be open ended in order to encourage an opportunity to respond in full and to provide additional comments which might be of significance

2. A determination of program personnel to be interviewed was made.

The interviews were conducted with the Deputy Program Managers for Logistics (DPMLs) or the Integrated Logistics Support Managers (ILSMs) for programs at ASD. AFR 800-8, Integrated Logistics Support Program, stipulates that these individuals are experienced logisticians who "assist in executing ILS responsibilities throughout the acquisition program" for major and less-than-major programs (AFR 800-8:7). Integrated Logistics Support (ILS) is defined as:

> . . . a disiplined, unified, and iterative approach to the management and technical activities necessary to: (a) integrate support considerations into system and equipment design; (b) develop support requirements that are related consistently to readiness objectives, to design, and to each other; (c) acquire the related support; (d) provide the required support during the operational phase at a minimum cost (AFR 800-8:7).

The qualifications, responsibilities, and personal involvement with all LCC aspects were assumed to be accurate and to provide for the required level of expertise to adequately respond to questions.

3. The number of interviews to be accomplished was determined.

ASD DPMLs and ILSMs for six major and seven less-than-major programs were interviewed. This was to allow for the capability to access efforts in programs of various sizes, and to provide a variety of responses due to varying approaches.

4. A determination of which programs to be selected was made.

Program selection was intended to allow for an appropriate balance between major and less than major programs, and to allow for a diversity of approaches and techniques to be reviewed.

Appendix A: Validation Panel lists the names and duty titles of the individuals on the Verification Panel. The Verification Panel consists of five Air Force Institute of Technology (AFIT) faculty members who possessed a wide range of expertise and experience with survey instrument development. The purpose of the validation panel is ensure that the informal interview questions will provide the data required to answer the research questions. Recommendations from these experts were incorporated.

Appendix B: Interview Questions contains the Interview Questions.

Appendix C: Interview Data contains the Responses to the Interview Questions.

Appendix D: Interview Subjects and Program Data contains a list of Interview Subjects. All offices on an organizational listing provided by the ASD staff were contacted, the interviews represent the responses from all available interviewees who wished to participate.

## Data Analysis

The Data Analysis consisted of the five steps.

1. The information was categorized into general areas designed to parallel the interview questions.

The interview questions included the following sections: subject and program size and cost data, interview data, LCC drivers and potential for savings, timing of LCC emphasis, most effective period for LCC emphasis, guidance and direction, impediments to integrating LCC and their elimination, cost estimating models and analyses, and general comments.

2. The responses to the interview questions were grouped or sorted depending upon the nature of the response (yes-no responses, yes-no responses with qualifications, specific choice questions, or discussion-type questions).

3. Yes-no responses with minimal qualifying discussion, and specific choice questions were displayed graphically. General comments were grouped or individually presented in list form.

4. The determination of whether or not trends or tendencies existed was made by both consistency of response and by majority response.

5. All trends or tendencies that appeared in the analyses were considered to warrant inclusion in the Conclusions section.

The names of the interviewees, the systems to which the interview questions pertained, the program size (major or less-than-major), and the approximate cost (R&D and production) of the programs are seperated from the responses presented in Appendix C. This data is provided in Appendix D. The separation of data was accomplished in order to maintain the policy of non-attribution by reducing the chance of correlating the responses with the interviewees. Specific data (with regard to exact models used, type of contract involved, etc.) was also withheld if it would allow for correlation to the interviewees.

Conclusions

The Conclusions section provided a summary of the individual areas addressed in the data analyses section. The general state of affairs for each area was presented as relayed through the data.

Recommendations

The Recommendations section suggested possible changes and made specific recommendations which would allow improved LCC utility.

# IV. Data Analysis

## Forward

Responses to the interview questions are included in Appendix C. Interviewee names and ranks, whether the programs managed were major or less-than-major programs, and the approximate dollar cost of the programs (in terms of R&D and production/modification) are included in Appendix D. This information was intentionally separated from the interview data in order to prevent responses from being correlated to the interviewees. The fifteen programs for which the data was compiled were in various acquisition stages, involved different classes of end-items (missiles, training, aircraft, modifications, etc.) and utilized numerous contracting strategies. The differing natures of the programs involved resulted in LCC issues and concerns being more applicable to some programs than to other. A "not applicable" response indicates that due to the nature or acquisition stage of the program the LCC question asked was not a current program issue. A not applicable response to a follow-up question resulted if the answer to the main question negated the need for the follow-up question. The data derived from the interviews is grouped or displayed depending on the nature and complexity of the responses. Where the responses are in the form of discussion or address a more general issue they are individually displayed.

Subject and Program Size and Cost Data

Rank. A breakdown of the interviewees by rank is displayed in Table 1.

TABLE 1

Breakdown of Interviewees by Rank

| Military | Number Interviewed (% of Sample) | Number of DPMLs/ILSMs From Which to Select (% of Population |
|---|---|---|
| Lt. Col. | 1 (6.7%) | 6 (7.4%) |
| Major | 2 (13.3%) | 8 (9.9%) |
| Captain | 3 (20.0%) | 11 (13.6%) |
| 1Lt. | 1 (6.7%) | 3 (3.7%) |
| 2Lt. | 0 (0.0%) | 5 (6.2%) |
| MSGT. | 0 (0.0%) | 2 (2.5%) |
| **Civilian** | **Number Interviewed (% of Sample)** | **Number of DPMLs/ILSMs From Which to Select (% of Population)** |
| GS/GM-13 | 2 (13.3%) | 9 (11.1%) |
| GS-12 | 6 (40.0%) | 33 (40.7%) |
| GS-11 | 0 (0.0%) | 3 (3.7%) |
| GS-9 | 0 (0.0%) | 1 (1.2%) |

The ratio of military and civilian interviewees and the ranks were representative of the distribution within ASD. Five of the programs were major and ten were less-than-major. The average cost for R&D and production for four of the major programs was $4.78 billion. The average

cost for nine of the less-than-major programs was $213.98 million. The costs for one major and one less-than-major program were unavailable.

Interview Data

Interviewee and program data is presented by question as they appear on the interviews in Appendix C.

Interviewee/Program Information. Questions: How many years experience do you have in acquisition logistics? At what level?

Years experience in acquisition logistics ranged from .75 years to 15 years. The mean is 3.58 years, the mode is 2 years, and the median is 3 years.

In ASD the ratio of ILSMs to DPMLs is 1.8/1. Of the interviewees nine were ILSMs and six were DPMLs (a ratio of 1.5/1).

Question: Do you have any formal LCC training or experience?

Table 2 lists the responses.

Eight of the interviewees (53.3%) had no LCC training of any kind. Of the seven interviewees who had some form of LCC training, all had taken the AFIT LCC course, QMT 353 (Intoduction to Life Cycle Costing), and three of those had taken an LCC workshop or another course dealing with LCC. Many of the interviewees indicated that the training received represented an overview of the modeling and analyses that existed and did not qualify them to manage LCC.

TABLE 2

LCC Training or Experience

| | NONE | AFIT (QMT 353 or Similar course) | OTHER (workshop, etc.) |
|---|---|---|---|
| 1. | | X | |
| 2. | X | | |
| 3. | X | | |
| 4. | | X | X |
| 5. | X | | |
| 6. | X | | |
| 7. | X | | |
| 8. | | X | |
| 9. | X | | |
| 10. | | X | |
| 11. | | X | X |
| 12. | X | | |
| 13. | X | | |
| 14. | | X | |
| 15. | | X | X |
| Total | 8 | 7 | 3 |

LCC drivers and Potential for Savings. Question: In order of significance (cost), what are the three largest LCC drivers for your program?

First, second, and third choices for the largest LCC drivers are given in Table 3 (X denotes no response).

TABLE 3

Largest LCC Drivers

| | FIRST | SECOND | THIRD |
|---|---|---|---|
| 1. | Acquisition | Peculiar support equipment (PSE) | Technical data |
| 2. | Acquisition | Training | X |
| 3. | Software | Acquisition | X |
| 4. | Software | Acquisition | SE |
| 5. | PSE | Spares | Logistic Support Analysis (LSA) |
| 6. | Software | Maintenance/ manpower | Depot costs |
| 7. | Acquisition | Maintenance | X |
| 8. | Support equipment (SE) | Spares | Technical data |
| 9. | O&S | Modifications | Software |
| 10. | Training | Manpower | Spares |
| 11. | Acquisition | X | X |
| 12. | Spares | Software | Technical data |
| 13. | X | X | X |
| 14. | Transportation | Reliability | X |
| 15. | Manpower | Fuel | SE |

Acquisition cost was given by four of the interviewees (26.7%) as the largest cost driver for their program. Software was the largest cost driver on three programs (20.0%), and support equipment (SE and PSE) was the largest cost driver on two of the programs (13.3%).

Questions: In view of the control you are allowed to exercise, which of the mentioned LCC drivers afford the greatest potential for savings? Why?

Responses to the questions are provided in Table 4.

TABLE 4

LCC Drivers Which Afford the Greatest Potential for Savings

| | CATEGORY | RATIONALE |
|---|---|---|
| 1. | Maintenance | System is maintenance intensive |
| 2. | Acquisition | Trade-offs possible |
| 3. | Acquisition | Trade-offs possible |
| 4. | SE | Size and quantities could be worked |
| 5. | Spares | Spare levels could be worked |
| 6. | Manpower | Trade-offs possible |
| 7. | Spares/SE | Trade-offs possible |
| 8. | Technical data | Trade-offs possible |
| 9. | O&S | Can be compeated |
| 10. | Training | Trade-offs possible |
| 11. | Acquisition | Trade-offs possible |
| 12. | Spares/technical data | Software too difficult to work |
| 13. | None | Part of contract price |
| 14. | Reliability | Trade-offs possible |
| 15. | Manpower | Trade-offs possible |

Acquisition and spares were listed three times each (20.0% each). Maintenance and manpower were listed twice (13.3%). The priciple reason given for an item being selected was that trade offs could be made.

Question: What changes, if any, do you feel would allow you to more effectively achieve LCC savings?

The responses are summarized as follows:

1. Buy off-the-shelf equipment (given by two interviewees).
2. Stabilize the budget and buy required systems on one contract as opposed to spreading the purchase out.
3. Address LCC early and improve reliability.
4. Allow more time to properly accomplish.
5. Improve modeling in order to provide concrete LCC data.
6. Allow for long term contracts.
7. Improve the configuration management of spares.
8. More real-time analyses with prototypes or firmer designs, more rapid turnaround on analyses, and more LCC expertise is needed.
9. "None" was the response of six interviewees.

Seven of the interviewees (46.7%) felt that LCC management did not need to be changed. An apparently significant trend that appeared was that six of the fifteen interviewees (40.0%) responded that there were no changes which would allow them to more effectively achieve LCC savings. Many of the interviewees were perplexed by the question and did not demonstrate an awareness of the scope of LCC considerations. Four of the interviewees responding

"none" to this question did provide recommendations for improvements when prompted by specific questions later in the interview.

Timing of LCC Emphasis. Questions: In which phase of the acquisition process did LCC first become a contractual concern (pre-conceptual, conceptual, demonstration/validation (dem/val), full scale engineering development (FSED), or production)? What was required contractually?

Responses to the above questions are provided in Table 5.

Six of the interviewees (40.0%) indicated their involvement in the program started after the conceptual phases and that they were most familiar with the efforts that transpired in that phase. Several of the interviewees, who were not involved with their program when LCC first became a contractual concern, indicated that they were unsure of the exact contractual requirements but indicated that they thought it was.

Of possible significance is the fact that three of the interviewees indicated that LCC was not a contractual concern during any stage of the acquisition process. The rationale given was that the program involved off-the-shelf equipment, a modification of an established weapon system, or a FFPI contract.

TABLE 5

Phase of the Acquisition Process in Which LCC First Became a Contractual Concern and the Contractual Requirement

| | ACQUISITION PHASE | CONTRACTUAL REQUIREMENT |
|---|---|---|
| 1. | Conceptual | Little or no maintenance |
| 2. | FSED | Design-to-cost data |
| 3. | Unknown | Unknown |
| 4. | FSED | LCC data deliverables |
| 5. | FSED | Unknown |
| 6. | Conceptual | LCC and Design to Cost (DTC) plans and data |
| 7. | FSED | LCC costing data |
| 8. | Not applicable-- Off-the shelf | |
| 9. | FSED | Trade-off-studies |
| 10. | Conceptual | Unknown |
| 11. | Not applicable-- Modification | |
| 12. | Pre-FSED | LCC management plan |
| 13. | Not applicable-- FFPI contract | |
| 14. | Conceptual | Trade-off studies & warranty |
| 15. | FSED | Baseline LCC and effects of changes |

Question: Was LCC considered during the design effort?

Seven interviewees (46.7%) responded "yes", six interviewees (40.0%) did not know, and two of the interviewees (13.3%) stated that LCC considerations were not applicable due to the nature of their program.

Questions: Was LCC a consideration for contract award? In what way?

Six interviewees (40.0%) responded "yes", three (20.0%) responded "no", two (13.3%) did not know, and four (26.7%) stated that LCC considerations were not applicable due to the nature of their program. Of those who responded "yes", five (83.3% of concerned sample) indicated that LCC was used as a source selection criteria, and one was unsure of how LCC was applied (although even this interviewee stated that it was a consideration). The four interviewees who stated that LCC was not applicable managed a FFP or set aside program.

Most Effective Period for LCC Emphasis. Question: Which phase of the acquisition process do you feel represents the greatest opportunity to address LCC?

The responses to the question and the qualifications given are provided in Table 6.

The majority of the interviewees indicated that LCC is best started early in the acquisition process. Three of the interviewees (20.0%) stated that planning was important for LCC implementation but that the most effective period

is in the FSED phase; they stressed the importance of having tangible equipment or engineering designs with which to work.

TABLE 6

Phase of the Acquisition Process Which Represents the Greatest Opportunity to Address LCC

| | ACQUISITION PHASE | QUALIFICATIONS (IF GIVEN) |
|---|---|---|
| 1. | Conceptual | Changes are possible |
| 2. | Pre-conceptual | Not possible with modifications if the system configuration is established |
| 3. | Pre-conceptual | |
| 4. | Pre-conceptual | LSA can be considered |
| 5. | FSED | Program is not well enough defined until then |
| 6. | Dem/val | |
| 7. | FSED | |
| 8. | Conceptual | Planning can be done |
| 9. | Conceptual | |
| 10. | Conceptual | |
| 11. | Conceptual | |
| 12. | Conceptual | FSED if off-the-shelf |
| 13. | Conceptual | |
| 14. | Conceptual | |
| 15. | FSED | Conceptual planning is required |

Guidance and Direction. Question: What guidance and direction do you reference for LCC management?

Twelve of the interviewees (80.0%) referenced the 800-series regulations, and five of those referenced other sources including AFP 70-1, LCC reports, the program management directive (PMD), ILS Guide for Acquisition Managers, staff assistance, and ALT (ALT is the Acquisition Logistics Concepts and Analysis Branch at ASD) handbooks. One interviewee (6.7%) was unsure or what was referenced for guidance and direction, and one left all LCC issues to the LCC monitor for his office.

Question: Do you believe that you are addressing LCC in the manner envisioned by existing guidance and direction, or that the requirement is simply being met?

Eight of the interviewees (53.3%) felt that LCC was being addressed as envisioned. Six of the interviewees (40.0%) felt that LCC actions were being accomplished in order to fill a square. One interviewee stated that LCC considerations were not applicable to the program they were managing.

Impediments to Integrating LCC and Their Elimination. Question: What impediments exist to integrating LCC into the decision making process (upper level commitment, guidance and direction, manpower, expertise, time, funds, etc.), and how would you rank them?

Responses and precedence are listed in Table 7.

TABLE 7

Number of Respondents Listing Specific Items as Impediments to Integrating LCC into the Decision Making Process

| | UPPER LEVEL COMMIT-MENT | GUIDANCE AND DIREC-TION | MANPOWER | EXPERTISE | TIME | FUNDS |
|---|---|---|---|---|---|---|
| 1st | 2 | 2 | 2 | 5 | 1 | 3 |
| 2nd | 1 | 3 | 2 | 2 | 4 | 1 |
| 3rd | 2 | 3 | 1 | 5 | 1 | 1 |

Comments regarding upper level commitment included:

1. Lack of depot involvement exists until program management responsibility turnover (PMRT) approaches.

2. There is a need for early implementation and consistent enforcement.

3. LCC becomes a square filling exercise without upper level commitment.

4. That program managers and engineers did not realize the benefits of a good LCC program.

5. Upper level commitment is occasionally lacking

Comments regarding guidance and direction included:

1. More emphasis is needed on less-than-major programs (this response was given by two of the interviewees).

2. Better policies are needed for handling value engineering change proposals (VECPs).

3. Better difinitions are required and LCC and DTC need to be differentiated.

4. Guidance and direction should provide for the development of better data bases for costing purposes.

5. Guidance and direction does not adequately cover LCC under contracted support.

6. Guidance and direction is sometimes lacking.

7. Guidance is complex and hard to apply.

Comments regarding manpower were as follows:

1. Shortages result in LCC being contracted out.

2. Manpower increases would provide the resources to convince management of LCC needs.

3. You have to pull teeth to get help.

4. Manpower is lacking (mentioned twice).

Comments regarding expertise were as follows:

1. There is a lack of LCC expertise in the logistics area

2. Logistics personnel are responsible for LCC without having the required experience; a core staff should be developed (and "properly" manned), and the staff (not the logisticians) should manage LCC.

3. Experience (which is lacking) would not be as significant a problem if less complex (and often as good or better models) were made more readily available.

4. Expertise required to understand the models and interpret the data is lacking.

The lack of expertise was one of the three primary concerns for all but two of the interviewees who provided a response to this question. The number of first, second, and third responses which pertained to the lack of experienced personnel (in regard to LCC skills) is shown in the matrix above. With twelve of the interviewees (80.0%) listing the lack of experience as one of their responses a significant concern is indicated.

Comments in regard to time were as follows:

1. There is a lack of time to properly accomplish LCC modeling and analyses.

2. Programs are usually compressed, and there is not enough time to accomplish all LCC requirements.

3. Ninety day source selection, streamlined acquisitions, and situations involving concurrency do not allow sufficient time for proper LCC application.

Comments in regard to funding were as follows:

1. The uncertainty of funding and lack of multi-year funding makes programs more costly.

2. Funding problems due to congressional/OSD cuts are significant; multi-year funding would facilitate management and provide for program stability.

3. Funding availability and timing is a problem.

4. Funding shortages result in failure to provide full support to some programs. These funding cuts generally leads to cuts in logistics funding.

Cost Estimating Models and Analysis. Question: Are you familiar with the various LCC modeling techniques which are most commonly used in your program?

Nine interviewees (60.0%) were vaguely familiar with the techniques used ("vaguely familiar", as defined by several interviewees, was being able to pick a name or technique out of a line up). Three interviewees (20.0%) were familiar with the LCC modeling techniques used on their program, two interviewees (13.3%) were not, and one stated that LCC modeling was not applicable to the program involved since it was FFP.

Question: What LCC models or analyses techniques were used in the various stages of your program?

Responses to the question are as follows:

1. Modeling and equations proved to be of no help--acquisition cost was used.
2. Modifications of existing models were used.
3. AFLC Network Repair Level Analysis model was used.
4. LCC-10A and LCC-2 (data for both had to be modified) were used.
5. The Cost Analysis Strategy Assessment (CASA) model was used.
6. Parts of LCC-2, Dyna-METRIC, L-COMM, and CORE were used.
7. Z-CORE and a modified Z-CORE were utilized for source selection.
8. Trade studies were used.

CASA was used on three programs and was seen as a step towards providing a simpler and less data absorbing model for purposes of analyzing costs. Three interviewees were unsure of which models were used or being used on their programs. One interviewee did no modeling for the program involved. Many of the interviewees stated that although modeling was accomplished the data was too difficult to interpret or the results proved less beneficial than heuristics due to accuracy and time limitations.

Question: How was the information used (as data for entry into the next phase, for trade off studies, for engineering analyses, etc.)?

Ten of the interviewees (66.7%) used the information for trade off studies and for engineering analyses, examples of which are as follows:

1. Access ECPs

2. Repair level analyses

3. Determine overall O&S costs

4. Source selection criteria

One interviewee also used the information for purposes of entering into the next acquisition phase. Two interviewees were unsure of how the data was used. One did not have LCC data generated for his program, and one was unsure of its use but thought that it was as a "square filler".

Question: Were competing contractors required to use the same LCC models and analyses techniques? If not, why?

Eight of the interviewees (53.3%) indicated that a specific model or specific models were provided or stipulated to be used by all contractors. Two of the interveewes (13.3%) were unsure. The rational given by the interviewees responding "no" is as follows:

1. The program is sole source or special consideration program (response given by three of the interviewees).

2. A FFP type of contract was involved.

3. Off-the-shelf equipment was used.

Questions: Was staff assistance given for the formulation and contractual implementation of LCC models and analyses used? Was it available?

Staff assistance was given on eleven of the fifteen programs (73.3%). One program received no staff assistance, but the interviewee stated that staff assistance was available. The interviewee in this case

indicated that due to staff manpower shortages all requests for assistance had to be forecast and this proved too awkward to bother with. Three of the programs (20.0%) did not require staff assistance for the following reasons (as given by the interviewees):

1. Contractor support was used for all modeling efforts.
2. A FFP type contract was involved.
3. Off-the-shelf equipment was used.

Questions: Was staff assistance given for the evaluation of data derived from LCC models or analyses used? Was it available?

Ten of the interviewees (66.7%) indicated that staff assistance was utilized. One interviewee indicated that staff assistance was not used, but was available. One interviewee indicated that staff assistance was available, but that due to the need to forecast staff assistance it was not used. Three of the programs did not require staff assistance for the following given reasons:

1. Contractor support was used for all modeling.
2. A FFP type contract was involved.
3. Off-the-shelf equipment was used.

Questions: Could the models and analyses be run and verified on computer systems available to the government? If so, could the modeling and analyses be performed on IBM compatible PCs, or were larger mainframe computers required?

The responses to the question were as follows:

1. Three of the interviewees (20.0%)indicated that the modeling was accomplished by the contractor on systems not available to the government.

2. Ten interviewees (66.7%)indicated the modeling could be run on Government systems (three required a mainframe, six could be run on an IBM PC compatible computer, and one interviewee was not sure).

3. One interviewee stated modeling was not required.

4. One interviewee did not know what systems the LCC modeling could be run on.

Question: Do you believe that LCC models which can be run on IBM compatible PCs would provide for more effective LCC management?

The responses to the question were as follows:

1. Four of the interviewees responded "yes" without any reservations.

2. Two interviewees responded "yes" but indicated that we did not have the experts to load, run, and analyze the data.

3. One interviewee indicated yes if the program was small enough and the data requirements were minimal.

4. Two of the interviewees said they were not sure. One interviewee said sometimes.

5. Five interviewees said "no"--four of those because they felt there was no time or a lack of expertise to run and analyze the data, and one because of a lack of faith in models altogether.

Question: Do you have any recommendations for improving the modeling and analyses for LCC?

Five interviewees (33.3%) responded "no", and one interviewee (6.7%) stated that LCC was a contractor concern (speaking in regard to FFP type contract) and there was no

need for it to be managed by program personnel. For the remaining interviewees the responses were as follow:

1. Modify the existing models to fit the programs, provide better and more up-to-date models, and update the terminology so that the results are understandable.

2. DoD should designate a limited number of joint service models so that guesswork can be eliminated and data can be comparable (same models, terms, criteria, etc.); despite flaws that exist in this approach it is better than thousands of different models that people are currently trying to track and understand.

3. Simplify the modeling and make it user friendly; give up some accuracy for simplicity; make LCC training or experts available.

4. Keep it simple; over analyses is not paying off; if FFP contract is involved take the lowest qualifying bid.

5. Expertise needs to be available to fit the model to the program; LCC costing models for O&S of software need to be made available.

6. More expertise is needed.

7. We need the capability to use less complicated and less time consuming models; although a degree of accuracy may be lost most mistakes would balance out and become relative amongst competing systems.

General Comments. Question: Do you have any general or specific comments that you would like to add regarding LCC?

Four of the interviewees gave no response. The remaining interviewees responded as follows:

1. Less-than-major programs are poorly addressed, and lack adequate direction; it is difficult to determine exactly what should be applied to less-than-major programs.

2. Producability enhancements and vigorous addressing of VECPs can drastically reduce LCC.

3. People do not receive adequate training in LCC; if logisticians are going to continue to be tasked with LCC management they should receive "proper" training.

4. A lot of boilerplating goes on during the building of requirements (partially due to the lack of familiarity with LCC and partly because of the maze of requirements that must be considered), this results in our getting as lot of data that is not required and that we do not really understand.

5. There is a serious problem with the fact that the DPML/ILSM is responsible for LCC without having the authority to manage it as required; the program manager (who holds the purse strings and who ultimately makes the decisions) should designate a project officer and provide the resources required.

6. Logisticians should not be responsible unless given the authority to implement and make timing allowances.

7. LCC and O&S costs are ignored in favor of the immediate acquisition costs; we are responsible but have no authority.

8. Give it to the people who have the time and the resources needed to do the job.

9. Too many requirements for expensive (and often unreliable) LCC data.

10. Logisticians cannot and should not be responsible since they do not have the models or the experience; an LCC office should be established and be made fully responsible; contractors are not incentivized to create supportable systems since they make money on spares.

11. LCC data generated using complicated models can lie and be very hard to understand; simpler models will facilitate and increase usage (heuristics is often adequate); LCC modeling often involves duplication of effort; low LCC does not equate to combat capability.

# V. Conclusions and Recomendations

## Conclusions

Forward. The Conclusions section consists of an interpretation of the Data Analysis chapter results. For the purposes of consistency each general area within the Data Analysis chapter is individually addressed and conclusions drawn.

### Experience Levels and Training

With regard to the number of years experience in acquisition logistics, a mean of 3.58 years with a mode of two years would seem to indicate a lack of permanence in positions where career professionals would be extremely useful. Even in the military, where pressure exists to career broaden and individuals often perform a number of vastly different duties during the course of their careers, this would indicate a lack of time and practical experience in the field. Most of the interviewees had worked only one or two programs and their experience was limited to what they had encountered in the work environment; this could not be expected to provide the breadth or level of understanding required to properly manage LCC implementation.

Eight of the interviewees had no LCC training at all. Three of the interviewees had taken the AFIT LCC course, QMT 353. The general impression was that QMT 353 provided

an overview of LCC models and analyses but did not provide the in-depth understanding that would be required to work and interpret the complex and varied models being utilized. Three of the interviewees had taken some form of training beyond QMT 353 including an LCC workshop and courses which dealt in part with LCC concerns.

DPMLs and ILSMs are responsible for the management of many integrated logistics support (ILS) elements each of which represents a major functional area once the system is fielded. LCC modeling incorporates significant amounts of data pertaining to each of the ILS elements and, through a process which ranges from difficult to overwhelming, transforms these data into output which must be analyzed and interpreted. Of the fifteen interviewees, not one professed to be more than vaguely familiar with LCC modeling and analyses techniques, and fifty three percent had no training at all. If LCC modeling and analyses had been accomplished, they were often limited in nature and seldom ongoing and iterative processes. Most interviewees were aware of the complexity of LCC modeling and analyses and acknowledged that extensive and in-depth training would be required for proper LCC management and for modeling and analysis. The interviewees indicated that they were under-manned and barely able to address the the seemingly endless requirements imposed. The interviewees indicated that the difficult and time consuming task of LCC modeling and analysis would be best relegated to an LCC expert (who

would be readily avaliable and responsible to them). The impression given was that if the DPMLs and ILSMs had the background and experience necessary, and they left the office to acquire proper training, that the program would go from the conceptual stage to production without anyone to address logistics concerns.

LCC application is tailored to the specific requirements of the program being worked. This limits the amount of exposure and interaction with the full range of LCC modeling and analyses techniques, and would result in the need for frequent and recurring training even if proficiency in LCC modeling and analyses initially existed. In an environment where even professional analysts are perplexed by the complexity of proper LCC application, to expect DPMLs and ILSMs to develop the required qualifications through on-the-job experience is unrealistic.

The lack of LCC expertise within the program office was the most significant impediment to proper LCC implementation. It was listed as a concern by all but two of the interviewees, and stressed repeatedly throughout the interviews. The data indicate that DPMLs and ILSMs do not have the training or background needed to properly model and analyze LCC data. The interviewees indicated that LCC modeling and analysis was a science, and that the typical DPML or ILSM does not necessarily possess the technical background which would be required if they were to be

trained as LCC experts. In view of this concern, and due to the number of other logistics elements the DPMLs and ILSMs are responsible for managing, the interviewees indicated that intensive training for the DPMLs and ILSMs was not as viable an option as the training of LCC specialists or experts who would be available and responsible to the logistics office on an ongoing basis. The development of a core staff of LCC experts was recommended by one interviewee, but the data suggest that expertise that was not co-located and responsive to the unpredictable timing and demands which exist on most programs is poorly utilized.

Cost Drivers

The significant cost drivers for the programs varied depending on the timing and the type of program involved. The answers varied among differing programs and among programs of similar type. Several significant trends appeared in the answers. Over a fourth of the interviewees felt that the acquisition cost was the largest cost driver on their program. Of the interviewees who gave acquisition cost as an LCC driver, several had to be prompted to give second and third choices for LCC drivers. This implies a lack of familiarity with the meaning of LCC and the impact of long-term O&S costs on total system cost. Most of the responses indicated that the interviewees were looking at near term budget and program concerns as opposed to long term LCC issues. One individual stated that there were no

LCC drivers due to the fact that his porgram involved a FFPI contract. This also indicates a lack of familiarity with LCC application.

With regard to cost drivers which afforded the greatest potential for savings the data demonstrate that the interviewees felt, if they were allowed the ability and resources to make needed trade offs, cost savings could be achieved.

Changes Which Would Allow for Increased Cost Savings

In regard to changes that would allow LCC savings to be more effectively achieved the most significant trend to appear was "none". Forty percent of the interviewees felt that there were no changes which would allow for more effective achievement of LCC savings. Three general responses were given more than once and they included stabilization of the budget, buying off-the-shelf, and improving the modeling and analyses. The responses to the question were contrasted with the interviewees impressions of whether or not interviewees felt that LCC was being implemented as envisioned by guidance and direction. The results are displayed in Table 8. One of the six interviewees who did not recommend changes indicated that LCC was not applicable since the program being managed involved a FFPI contract. Two of the interviewees not recommending changes also indicated that LCC was not being applied as envisioned. This inconsistency either

demonstrates a a lack of awareness with proper LCC application or less than accurate responses to the related questions.

TABLE 8

Correlation Between Recommended Changes, and Whether or not LCC is Being Applied as Envisioned (X Denotes Yes)

| | RECOMMENDED CHANGES | LCC IS BEING APPLIED IN THE MANNER ENVISIONED |
|---|---|---|
| 1. | X | X |
| 2. | X | X |
| 3. | | |
| 4. | X | |
| 5. | X | X |
| 6. | X | |
| 7. | | |
| 8. | X | |
| 9. | | X |
| 10. | X | X |
| 11. | | X |
| 12. | X | |
| 13. | | Stated that LCC was not applicable to FFPI contract |
| 14. | | X |
| 15. | X | X |

LCC Timing

With regard to when LCC first became a contractual concern, and what was required, several items surfaced. First, the majority of the interviewees became involved or were aware of the initial LCC requirements in the FSED phase. Significant emphasis on LCC in the conceptual (or pre-conceptual) phase was not shown to exist.

Second, contractual requirements did not demonstrate consistently applied requirements for LCC. A combination of trade off studies, management plans, costing data, and other data was required on the various programs, but proper management of LCC requirements and timing did not seem to exist.

Third, it became apparent that interviewees with programs involving modifications, off-the-shelf equipment, or a FFP type contract felt that LCC is not a significant item of concern (if a concern at all). This third trend is alarming in view of the number of FFP or FFPI contracts that exist, and the combined cost savings that might be being overlooked. It also reflects the degree to which training might be lacking.

With regard to whether LCC was considered during the design effort the majority of the interviewees either did not know or stated that LCC consideration did not apply to their program. Most of the interviewees were not involved in their particular program during initial design. This was not due as much to the length of the program run as it

was to the newness of the interviewees' arrival to the program. This also demonstrates a lack of program continuity which has manifested itself into a lack of program knowledge and awareness.

The majority of the respondents indicated that LCC was not a consideration for contract award. Of the interviewees that indicated that it was, almost all indicated that it was as a criteria for source selection (usually considered as part of supportability); however, it was used as little more than a tie-breaker, and cost, schedule, and performance were still the driving criteria. This would imply that the the interviewees who responded that LCC was being applied as envisioned by guidance and direction (see Table 8) may not have been familiar with the extent of LCC application that was intended. It would also suggest that cost, schedule, and performance are by far the most significant considerations during system acquisitions and that out-year costs are not obtaining the emphasis that is warranted.

With regard to the phase of the acquisition process which represented the greatest opportunity to address LCC one might conclude that the relatively high percentage of interviewees responding pre-conceptual or conceptual would indicate an awareness of the importance of early LCC management. The interviewees answering FSED or demonstration/validation stressed the importance of LCC planning, but also stressed the need to have tangible

equipment or firm designs with which to work. The later concern is real, but to effectively accomplish LCC savings in later program stages more time will have to be scheduled for required studies.

The emphasis of LCC considerations in early program phases could be expected to reduce the amount and cost of changes which occur as a system develops and provide the largest potential for cost reductions. The emphasis on weighting of LCC as a criteria for contract award could serve to generate contractor concern; however, to further ensure contractor concern, we must provide the proper potential for return and compensate for profits which might be lost due to the new emphasis.

Guidance and Direction

With regard to the guidance and direction referenced for LCC management one might conclude that the expressed lack of an in-depth understanding of the regulations or of their application indicate a lack of proper LCC training and time to properly accomplish LCC requirements. One might conclude from the relatively high percentage (72.7% of those responding) of interviewees who felt that guidance and direction was inadequate that a significant problem exists. The interviewees indicated that current guidance and direction is complex and hard to apply. The complexity of guidance and direction and the degree of difficulty in its application could be a factor in its not being properly utilized. The boilerplating that goes on during the

building of requirements appears to be the result of the lack of LCC expertise and the complexity of the guidance and results in reams of expensive data that is often poorly utilized.

Guidance and direction does not adequately cover less-than-major programs. The data indicate that, for less-than-major programs, a simpler method for tailoring LCC data requirements for the variety of program phases and types is needed. There is also a need to clarify terms, and to include procedures for the handling of VECPs and LCC under Contractor Support.

Even with the guidance and direction which is in place it would appear that LCC is not getting the attention it deserves. Its implementation has often been sporadic and haphazard despite its frequent successes when properly applied (as with the F/A-18 example presented earlier).

Modeling

Responses to questions dealing with the familiarity of interviewees with modeling techniques used on their programs show that a significant problem exists. Interviewees were generally frustrated with the complexity and frequent inadequacies of present models and analysis techniques.

Much of the data derived from the modeling is not utilized because the data are too difficult to interpret. Many of the interviewees indicated that when accurate data

and time are lacking information derived from complex modeling and analyses often proved to be less beneficial than heuristics. The modeling, if used, basically served for purposes of trade off studies and engineering analyses. When programs are being competed and modeling is used, the trend was for specific models to be either specified or provided by the government.

Staff assistance, both for formulation and contractual implementation of LCC models, and for the evaluation of data derived from LCC models and analyses, was generally available. Manpower shortages in staff resulted in LCC assistance having to be forecast. This presented a serious problem for several interviewees who indicated that this was the reason staff assistance was not fully utilized.

Most of the interviewees indicated that the modeling and analyses for their programs could be run and verified on systems available to the government. With regard to whether interviewees felt modeling which could be done on an IBM compatible PC provided for more effective LCC management the most frequent response was "no". Most interviewees felt that there was no time or a lack of expertise to run and analyze the data.

The interviews indicated that the ability to tailor models to meet specific program requirements is essential, and that simplification of the models that are used is needed. Simplification of the models (and making them less time consuming) was desired even if it meant giving up a

degree of accuracy. It was felt that any loss of accuracy that "may" occur would be mitigated by consistency of application by competing contractors.

Impediments to Integrating LCC and Their Elimination

Upper level commitment is lacking in two basic forms, that of depot involvement which often does not exist until PMRT approaches, and that of program managers and engineers not being fully involved in LCC efforts.

Shortages in manpower exist, both within the program offices and in the staff. This results in many of the LCC requirements being contracted out, being ignored altogether, or in less than adequate management.

Time and funding are often interrelated in their effect on LCC management. The uncertainty of funding due to congressional and OSD cuts and shifts in multi-year funding policy create significant problems for program management in general, and have an even greater impact on LCC management. The interview data and literature review indicate that cost cuts and slack time tends to affect logistic concerns prior to affecting overall schedule and performance requirements. Funding for concerns that greatly affect outyear O&S cost but which have little or no immediate payback is often the first to go; this is especially true if there is a sizable cost associated with it. Concurrency of program phases, streamlined acquisitions, and 90-day source selections do not allow sufficient time for proper LCC application.

There appears to be a a serious problem in that DPMLs and ILSMs are responsible for LCC without having the authority to manage it as is required. Six of the eleven interviewees who provided general comments regarding LCC addressed the issue of DPMLs and ILSMs having the responsibility for LCC without having the authority and resources needed for its effective management. The lack of authority and resources was the most strongly expressed concern and was not prompted by a specific question. The data demonstrate that the ability to make required trade-offs represented one of the major opportunities to achieve cost savings. Without the ability to "effectively" manage LCC issues, optimum cost savings will not be achieved.

## Recommendations

Forward. These recommendations are intended to be beneficial and possible given current and expected budgetary, political, and technical realities.

Recommended Procedures/Research. Government and contractors must become aware of potential savings in LCC and that they will no longer be able to ignore LCC if they wish to maintain a desired level of combat capability. In the literature review it was asserted that even the most pessimistic estimates on cost savings would be sufficient to allow future acquisitions to receive a greater share of the defense budget than currently enjoyed. In the literature review it was also asserted that this is not a

change that we would have to pay for, rather, it is one which will pay us. By ignoring LCC now, we will be limiting the number of new systems we are able to develop in the future. The mind-sets which have allowed the situation to persist should be dealt with via a mixture of education, mandatory procedures and guidelines, and if necessary, removal of those individuals failing to implement them. There are no valid reasons not to consider LCC in system design and the capability to do so should be improved and facilitated.

Many of the LCC initiatives are voluntary, and a wide degree of latitude in application exists. This results in LCC considerations being among the first to be eliminated when immediate cost cuts are deemed necessary. Most LCC considerations are contrary to the very nature of program managers and engineers who are evaluated more on near term performance and results that long term costs; therefore, oversight and direction must begin at the top and be worked down through the various layers and functional areas. We cannot allow the pressure to be reduced once established. Failing to implement the changes required could result in out-year O&S costs and might represent a serious threat to our ability to provide adequate defense of the nation.

LCC training should be improved in order that more and better expertise can be made available for LCC modeling and implementation. Research should be accomplished to determine the appropriateness of tasking the acquisition

logisticians with LCC modeling and analysis responsibilities.

Funding and timing issues resulting from congressional and OSD cuts, and the lack of stable multi-year funding should be addressed by a firm commitment to longer term funding and an emphasis on providing time in the acquisition process to adequately accomplish LCC requirements. Those responsible for determining the availability and timing of funds are often the first to voice discontent when the required support is not available, when program delays occur, or when the contract methodology that results is far from optimal. Research is required to determine the most appropriate method of effecting these changes.

Concerns over program delays which have resulted in cost overruns have shifted much of the program emphasis to meeting often rigid schedules. When possible and appropriate prototypes and firm designs should be built or established for effective trade off studies and engineering analyses to be accomplished. Cost-benefit-analysis of alternatives or improvements which might afford significant long-term cost savings should also be evaluated. This would entail, in some cases, a shift away from the 90-day source selection, streamlined acquisition procedures, and concurrency of acquisition phases. Research is required to determine the benefits that could be derived by providing more up front time for LCC planning and analyses.

LCC guidance and direction should be broadened to address LCC concerns that are not geared specifically towards major programs. Research is required to determine how guidance and direction can be simplified and what changes would improve its ease of use and application.

Shortages in manpower available for logistics functions and for LCC modeling and analyses need to be resolved. Research to investigate the feasibility of increasing acquisition logistics manning is recommended. An analysis of the impact that more effective LCC management would have on the future O&S manning requirements of systems being fielded is recommended. It is very likely that future O&S manning requirements could be significantly reduced by better up front acquisition planning, and that a small percentage of the personnel made available could be used to supplement acquisition logistics manning.

In view of the concern that logisticians do not have the authority or the resources (funds, time, LCC expertise) to effectively manage LCC, the following are recommended:

1. Establish separate funding for LCC management purposes.

The funding should be determined at the earliest program stage possible and should parallel the allocation of funds for the overall system. The use of such funds should be broadly defined in order to allow the latitude required by the DPMLs and ILSMs in order to effectively manage LCC.

2. The establishment of a DPML and ILSM should parallel that of the program manager.

This would help to ensure that LCC issues and concerns would be addressed in a timely manner, and would be most cost effective. Timing allowances should also be made for the proper application of modeling and for the analyses of the resulting data. Although program schedule slips can be costly an awareness of long term cost savings made possible through effective LCC application is needed.

3. The number of LCC experts needs to be expanded.

LCC experts need to be placed under the direct control of the DPMLs and ILSMs. This would help to ensure that the logistics elements for which the DPMLs and ILSMs are held accountable are adequately addressed in LCC modeling and analyses. The LCC experts should not be delegated the program reponsibilities of the DPMLs and ILSMs, but rather, they should be specifically and soley tasked for LCC modeling and analyses. The LCC experts should not be made available by depleting staff resources; staff manning is currently barely adequate for the proper control, coordination, and research that is required for the proper overview of LCC. Staff should remain as an interface between the functional area LCC experts and the guidance and direction changes, and modeling and analyses innovations. Manning for the additional LCC experts required should be allocated from both AFSC and AFLC in a fashion similar to the allocation of DPMLs and ILSMs.

4. More training should be required for all acquisition personnel to include the program manager, engineers, and logistics personnel.

This training should concentrate on modeling and analyses techniques being used for specific program types and should be recurring in nature. The intent of the training should not, however, be to qualify the trainees as LCC experts. This would be impractical due to the reasons mentioned earlier. This approach, although time consuming, would help to ensure LCC awareness, allow for specific knowledge required to better understand the complex issues at hand, and allow for improved interaction with the LCC expert for the program office.

Recommended Techniques/Research. The development of a limited number of joint service models should be accomplished by DoD. These standardized models should then be provided to the various services and contractors. Guidelines should be established to regulate the type and scope of changes that could be made by the individual services, and a feedback loop should be established to ensure that the modeling and analyses techniques are providing the desired results. This would eliminate much of the guesswork and confusion which now exists, and would provide basic frameworks required to standardize the multitude of models, terms, and criteria presently being employed. Research to determine the number and types of models which should be designated is recommended. Research is also recommended to determine if less compl[illegible]

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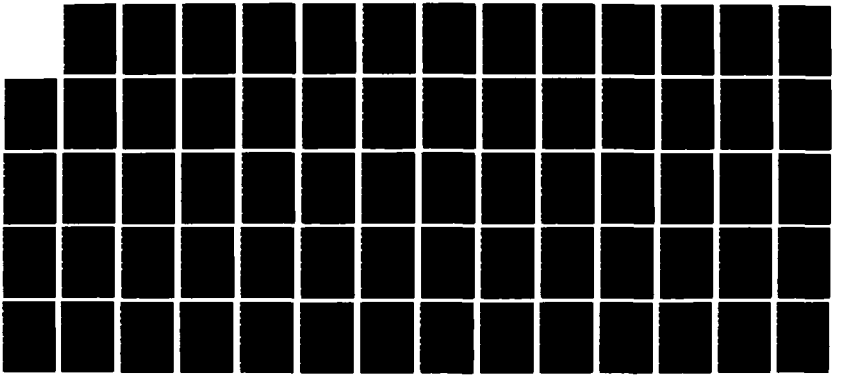

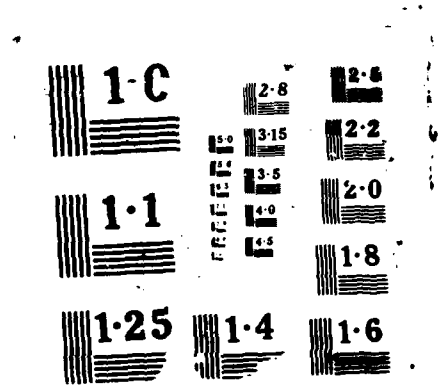
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less data intensive models and analyses techniques could be developed.

Specific tailoring of standard models developed by DoD (to enhance their suitability to individual programs) should be managed by the Air Force Acquisition Logistics Center (AFALC) with the assistance and cooperation of AFSC and AFLC. AFALC would serve as a consolidator and a mediator between the desires, needs, and concerns of AFLC, AFSC, and the using commands. The use of simpler models (and occasionally heuristics) has been demonstrated to provide equivalent or better results. Research for the purpose of determining the appropriateness of less complex models and the affect they would have due to increased use is recommended.

## Appendix A: Validation Panel

Panel members are as follows:

Lt. Col. John Long
AFIT/LSQ
Department Head, Department of Quantitative Management
Specialties--operations research, acquisition, cost-estimating, risk, reliability

Lt. Col. Paul Reid
AFIT/LSMA
Deputy Head, Department of Logistics Management
Specialties--cost-estimating, education, logistics management, logistics support, maintenance management, management information system

Professor Roland Kankey
AFIT/LSQ
Course Director for LCC (1978-1980, 1986)
Specialties--cost-estimating, economic analyses, models

Captain Carl Davis
AFIT/LSR
Course Director for Research Methods
Specialties--research management, education

## Appendix B: Interview Questions

Interviewee/Program Information

Interview Number:

Interviewee Rank:

1. How many years experience do you have in acquisition logistics? At what level?
2. Do you have any formal LCC training or experience?
3. Do you manage a major or less than major program?
4. What is the approximate dollar cost of your program (R&D and production)?

LCC drivers and Potential for Savings

1. In order of significance (cost), what are the three largest LCC drivers for your program?
2. In view of the control you are allowed to exercise, which of the mentioned LCC drivers afford the greatest potential for savings?

   Why?
3. What changes, if any, do you feel would allow you to more effectively achieve LCC savings?

Timing of LCC Emphasis

1. In which phase of the acquisition process did LCC first become a contractual concern (pre-conceptual, co·ceptual, dem/val, FSED, or production)?

   What was required contractually?
2. Was LCC considered during the design effort?

3. Was LCC a consideration for contract award?

In what way?

Most Effective Period for LCC Emphasis

1. Which phase of the acquisition process do you feel represents the greatest opportunity to address LCC?

Guidance and Direction

1. What guidance and direction do you reference for LCC management?

2. Do you believe that you are addressing LCC in the manner envisioned by existing guidance and direction, or that the requirement is simply being met?

Impediments to Integrating LCC and Their Elimination

1. What impediments exist to integrating LCC into the decision making process (upper level commitment, guidance and direction, manpower, expertise, time, funds, etc.), and how would you rank them?

Cost Estimating Models and Analysis

1. Are you familiar with the various LCC modeling techniques which are most commonly used in your program?

2. What LCC models or analyses techniques were used in the various stages of your program?

3. How was the information used (as data for entry into the next phase, for trade off studies, for engineering analyses, etc.)?

4. Were competing contractors required to use the same LCC models and analyses techniques?

If not, why?

5. Was staff assistance given for the formulation and contractual implementation of LCC models and analyses used?

Was it available?

6. Was staff assistance given for the evaluation of data derived from LCC models or analyses used?

Was it available?

7. Could the models and analyses be run and verified on computer systems available to the government? If so, could the modeling and analyses be performed on IBM compatible PCs, or were larger mainframe computers required?

8. Do you believe that LCC models which can be run on IBM compatible PCs would provide for more effective LCC management?

9. Do you have any recommendations for improving the modeling and analyses for LCC?

General Comments

1. Do you have any general or specific comments you would like to add regarding LCC?

## Appendix C: Interview Data

### Interviewee Data

The interviews which follow are presented in the order in which conducted.

### Interviewee/Program Information

Interview Number: 1

1. How many years experience do you have in acquisition logistics? 2

At what level? ILSM

2. Do you have any formal LCC training or experience? No--QMT 353 [AFIT "Introduction to Life Cycle Costing" course] was taken

### LCC drivers and Potential for Savings

1. In order of significance (cost), what are the three largest LCC drivers for your program?

a. Acquisition costs

b. Maintenance (on peculiar support equipment [PSE])

c. Documentation

2. In view of the control you are allowed to exercise, which of the mentioned LCC drivers afford the greatest potential for savings? Maintenance on PSE

Why? Acquisition and documentation costs are determined

3. What changes, if any, do you feel would allow you to more effectively achieve LCC savings? Buying off-the-shelf equipment with known characteristics

Timing of LCC Emphasis

1. In which phase of the acquisition process did LCC first become a contractual concern (pre-conceptual, conceptual, demonstration/validation [dem/val], full-scale engineering and development [FSED], or production)? Conceptual

What was required contractually? Little or no maintenance

2. Was LCC considered during the design effort? Yes

3. Was LCC a consideration for contract award? Yes

In what way? It was used as a weighting factor in source selection

Most Effective Period for LCC Emphasis

1. Which phase of the acquisition process do you feel represents the greatest opportunity to address LCC? Conceptual--since changes are possible at least cost

Guidance and Direction

1. What guidance and direction do you reference for LCC management? 800 series regulations

2. Do you believe that you are addressing LCC in the manner envisioned by existing guidance and direction, or that the requirement is simply being met? In the manner envisioned

Impediments to Integrating LCC and Their Elimination

1. What impediments exist to integrating LCC into the decision making process (upper level commitment, guidance and direction, manpower, expertise, time, funds, etc.), and how would you rank them?

a. Guidance and direction, although adequate, should place more emphasis on less-than-major programs

b. The uncertainty of funding and lack of multi-year funding (in some cases) makes programs more costly

c. There is a lack of LCC expertise in the logistics area

Cost Estimating Models and Analysis

1. Are you familiar with the various LCC modeling techniques which are most commonly used in your program? Vaguely familiar

2. What LCC models or analyses techniques were used in the various stages of your program? No real modeling was employed. Equations were used and proved to be of no help, and we resorted to the use of acquisition cost in and of itself.

3. How was the information used (as data for entry into the next phase, for trade off studies, for engineering analyses, etc.)? For trade off studies

4. Were competing contractors required to use the same LCC models and analyses techniques? Yes

If not, why? Not applicable

5. Was staff assistance given for the formulation and contractual implementation of LCC models and analyses used? Yes

Was it available? Yes

6. Was staff assistance given for the evaluation of data derived from LCC models or analyses used? Yes

Was it available? Yes

7. Could the models and analyses be run and verified on computer systems available to the government? Not required

If so, could the modeling and analyses be performed on IBM compatible personal computers (PCs), or were larger mainframe computers required? Not applicable

8. Do you believe that LCC models which can be run on IBM compatible PCs would provide for more effective LCC management? Yes

9. Do you have any recommendations for improving the modeling and analyses for LCC? No

General Comments

1. Do you have any general or specific comments that you would like to add regarding LCC? Less-than-major programs are poorly addressed, and lack adequate direction. It is difficult to determine what should be applied to less-than-major programs.

Interviewee/Program Data

Interview Number: 2

1. How many years experience do you have in acquisition logistics? 4

At what level? DPML

2. Do you have any formal LCC training or experience? No

LCC drivers and Potential for Savings

1. In order of significance (cost), what are the three largest LCC drivers for your program?

a. Acquisition cost

b. Training

c. (None given)

2. In view of the control you are allowed to exercise, which of the mentioned LCC drivers afford the greatest potential for savings? Acquisition costs

Why? Trade-offs can be made

3. What changes, if any, do you feel would allow you to more effectively achieve LCC savings? Stability of the budget which would allow for economic order quantities

Timing of LCC Emphasis

1. In which phase of the acquisition process did LCC first become a contractual concern (pre-conceptual, conceptual, dem/val, FSED, or production)? FSED

What was required contractually? Design to cost

2. Was LCC considered during the design effort? Yes

3. Was LCC a consideration for contract award? No--it was a sole source procurement

In what way? Not applicable

Most Effective Period for LCC Emphasis

1. Which phase of the acquisition process do you feel represents the greatest opportunity to address LCC? Normally in the pre-conceptual phase, but this may not be possible in the case of modifications or derivations of established systems

Guidance and Direction

1. What guidance and direction do you reference for LCC management? 800-series--but usually not involved with LCC

2. Do you believe that you are addressing LCC in the manner envisioned by existing guidance and direction, or that the requirement is simply being met? As envisioned

Impediments to Integrating LCC and Their Elimination

1. What impediments exist to integrating LCC into the decision making process (upper level commitment, guidance and direction, manpower, expertise, time, funds, etc.), and how would you rank them?

a. Funding is the largest problem and is due to Congressional/Office of Secretary of Defense (OSD) cuts. Multi-year funding would facilitate management and provide required stability.

b. Guidance and direction should provide policy for handling value engineering change proposals (VECPs) on dual source programs (proprietary data for individual contractors presents a problem).

c. More expertise is needed

Cost Estimating Models and Analysis

1. Are you familiar with the various LCC modeling techniques which are most commonly used in your program? Yes

2. What LCC models or analyses techniques were used in the various stages of your program? An existing model for the specific weapon type was used [specific weapon type

omitted to avoid identification of interviewee] ; an LCC model (which would determine the cost of ownership) is being developed.

3. How was the information used (as data for entry into the next phase, for trade off studies, for engineering analyses, etc.)? To access the impact of engineering change proposals (ECPs) on LCC

4. Were competing contractors required to use the same LCC models and analyses techniques? Yes--model was provided by the government for use by all contractors

If not, why? Not applicable

5. Was staff assistance given for the formulation and contractual implementation of LCC models and analyses used? Yes

Was it available? Yes

6. Was staff assistance given for the evaluation of data derived from LCC models or analyses used? Not needed

Was it available? Yes

7. Could the models, and analyses be run and verified on computer systems available to the government? Yes

If so, could the modeling and analyses be performed on IBM compatible PCs, or were larger mainframe computers required? Mainframe was required

8. Do you believe that LCC models which can be run on IBM compatible PCs would provide for more effective LCC management? Yes--they would be readily accessible and could be common to all offices

9. Do you have any recommendations for improving the modeling and analyses for LCC? Modify existing models to fit programs as appropriate; models for similar weapon types often provide less-than-adequate modeling and data

General Comments

1. Do you have any general or specific comments that you would like to add regarding LCC? Producability enhancements and vigorous addressing of value engineering change proposals (VECPs) can drastically reduce LCC

Interviewee/Program Information

Interview Number: 3

1. How many years experience do you have in acquisition logistics? 9 months

At what level? ILSM

2. Do you have any formal LCC training or experience? No

LCC drivers and Potential for Savings

1. In order of significance (cost), what are the three largest LCC drivers for your program?

a. Software

b. Components

c. (None given)

2. In view of the control you are allowed to exercise, which of the mentioned LCC drivers afford the greatest potential for savings? Components

Why? Trade-offs on parts can be made

3. What changes, if any, do you feel would allow you to more effectively achieve LCC savings? None

Timing of LCC Emphasis

1. In which phase of the acquisition process did LCC first become a contractual concern (pre-conceptual, conceptual, dem/val, FSED, or production)? Unknown

What was required contractually? Unknown

2. Was LCC considered during the design effort? Yes

3. Was LCC a consideration for contract award? Yes

In what way? Not sure--not involved in the program at that time

Most Effective Period for LCC Emphasis

1. Which phase of the acquisition process do you feel represents the greatest opportunity to address LCC? Pre-conceptual

Guidance and Direction

1. What guidance and direction do you reference for LCC management? 800-series and LCC pamphlets

2. Do you believe that you are addressing LCC in the manner envisioned by existing guidance and direction, or that the requirement is simply being met? Filling the square

Impediments to Integrating LCC and Their Elimination

1. What impediments exist to integrating LCC into the decision making process (upper level commitment, guidance and direction, manpower, expertise, time, funds, etc.), and how would you rank them?

a. Guidance and direction needs to be more specific with regard to LCC and design to cost (DTC). LCC and DTC are often interchanged and this results in confusion

(comparison is difficult if the same thing is not required for items being competed).

b. Upper level commitment at depot is often lacking until they own the equipment (or at the point of transfer).

c. Funding availability and timing is sometimes a problem.

Cost Estimating Models and Analysis

1. Are you familiar with the various LCC modeling techniques which are most commonly used in your program? Somewhat

2. What LCC models or analyses techniques were used in the various stages of your program? AFLC Network Repair Level Analysis model

3. How was the information used (as data for entry into the next phase, for trade off studies, for engineering analyses, etc.)? Repair level analyses and for trade offs

4. Were competing contractors required to use the same LCC models and analyses techniques? Yes--models were provided by the Government

If not, why? Not applicable

5. Was staff assistance given for the formulation and contractual implementation of LCC models and analyses used? Yes

Was it available? Yes

6. Was staff assistance given for the evaluation of data derived from LCC models or analyses used? Yes

Was it available? Yes

7. Could the models, and analyses be run and verified on computer systems available to the government? Yes

If so, could the modeling and analyses be performed on IBM compatible PCs, or were larger mainframe computers required? Larger mainframe

8. Do you believe that LCC models which can be run on IBM compatible PCs would provide for more effective LCC management? Not sure

9. Do you have any recommendations for improving the modeling and analyses for LCC? Improve and update models

General Comments

1. Do you have any general or specific comments that you would like to add regarding LCC? No

Interviewee/Program Information

Interview Number: 4

1. How many years experience do you have in acquisition logistics? 5

At what level? DPML

2. Do you have any formal LCC training or experience? A variety of AFIT courses and a workshop

LCC drivers and Potential for Savings

1. In order of significance (cost), what are the three largest LCC drivers for your program?

a. Software

b. End Item

c. Support equipment (SE)

2. In view of the control you are allowed to exercise, which of the mentioned LCC drivers afford the greatest potential for savings? SE

Why? Reductions in size and in quantities were achievable

3. What changes, if any, do you feel would allow you to more effectively achieve LCC savings? Early addressing of LCC, and improving the reliability of the end item

Timing of LCC Emphasis

1. In which phase of the acquisition process did LCC first become a contractual concern (pre-conceptual, conceptual, dem/val, FSED, or production)? FSED

What was required contractually? LCC data was a deliverable

2. Was LCC considered during the design effort? Not sure-was not involved

3. Was LCC a consideration for contract award? Not sure-believe that performance and cost were primary issues

In what way? Not applicable

Most Effective Period for LCC Emphasis

1. Which phase of the acquisition process do you feel represents the greatest opportunity to address LCC? Pre-conceptual--LSA should be considered in the design

Guidance and Direction

1. What guidance and direction do you reference for LCC management? Not sure--LCC report is received annually and reviewed

2. Do you believe that you are addressing LCC in the manner envisioned by existing guidance and direction, or that the requirement is simply being met? Filling the square--should be initiated in the design phase to be effective and carried through

Impediments to Integrating LCC and Their Elimination

1. What impediments exist to integrating LCC into the decision making process (upper level commitment, guidance and direction, manpower, expertise, time, funds, etc.)?

a. Manpower shortages result in LCC being contracted out

b. Lack of time to properly accomplish LCC modeling and to analyze the data

c. Upper level commitment should ensure LCC's early implementation and consistent enforcement

Cost Estimating Models and Analysis

1. Are you familiar with the various LCC modeling techniques which are most commonly used in your program? Yes

2. What LCC models or analyses techniques were used in the various stages of your program? Not sure

3. How was the information used (as data for entry into the next phase, for trade off studies, for engineering analyses, etc.)? For trying to come up with good estimates on spares, replenishment spares, depot costs, support equipment, and cost effectiveness of interim contractor support (ICS)--Once a baseline was established modeling was

then used to evaluate proposed changes and to develop O&S estimates

4. Were competing contractors required to use the same LCC models and analyses techniques? No

If not, why? Program was sole source

5. Was staff assistance given for the formulation and contractual implementation of LCC models and analyses used? Yes

Was it available? Yes

6. Was staff assistance given for the evaluation of data derived from LCC models or analyses used? Initially

Was it available? Yes; but limited due to the late phase of the program (few changes to status)

7. Could the models and analyses be run and verified on computer systems available to the government? No

If so, could the modeling and analyses be performed on IBM compatible PCs, or were larger mainframe computers required? Not applicable

8. Do you believe that LCC models which can be run on IBM compatible PCs would provide for more effective LCC management? Yes; but we still lack experts to do the analyses

9. Do you have any recommendations for improving the modeling and analyses for LCC? We need to update the terminology and models so that results are nderstandable--we often resort to boilerplating the requirements due to a lack of time and expertise

## General Comments

1. Do you have any general or specific comments that you would like to add regarding LCC? People do not receive adequate training in LCC--If logisticians are going to continue to be tasked with LCC management they should receive "proper" training

## Interviewee/Program Information

Interview Number: 5

1. How many years experience do you have in acquisition logistics? 1.5

   At what level? DPML

2. Do you have any formal LCC training or experience? No

## LCC drivers and Potential for Savings

1. In order of significance (cost), what are the three largest LCC drivers for your program?

   a. PSE

   b. Spares

   c. LSA data base

2. In view of the control you are allowed to exercise, which of the mentioned LCC drivers afford the greatest potential for savings? Spares

   Why? PSE was mandated to the SRU level and the LSA was required to be accomplished (and was tailored adequately)

3. What changes, if any, do you feel would allow you to more effectively achieve LCC savings? More time to properly accomplish

Timing of LCC Emphasis

1. In which phase of the acquisition process did LCC first become a contractual concern (pre-conceptual, conceptual, dem/val, FSED, or production)? FSED

What was required contractually? Unknown--not involved with the program at that time

2. Was LCC considered during the design effort? Unknown

3. Was LCC a consideration for contract award? Unknown

In what way? Not applicable

Most Effective Period for LCC Emphasis

1. Which phase of the acquisition process do you feel represents the greatest opportunity to address LCC? FSED--since the program is not well enough defined until then

Guidance and Direction

1. What guidance and direction do you reference for LCC management? 800-series regulations

2. Do you believe that you are addressing LCC in the manner envisioned by existing guidance and direction, or that the requirement is simply being met? As envisioned

Impediments to Integrating LCC and Their Elimination

1. What impediments exist to integrating LCC into the decision making process (upper level commitment, guidance and direction, manpower, expertise, time, funds, etc.)?

a. Funding to adequately s·pport programs (all requirements) is lacking

b. Not enough time to accomplish all requirements imposed--programs are usually compressed in some way

c. There is a lack of experienced people

Cost Estimating Models and Analysis

1. Are you familiar with the various LCC modeling techniques which are most commonly used in your program? Not completely

2. What LCC models or analyses techniques were used in the various stages of your program? Unknown

3. How was the information used (as data for entry into the next phase, for trade off studies, for engineering analyses, etc.)? For purposes of trade off studies and for engineering analyses

4. Were competing contractors required to use the same LCC models and analyses techniques? Unknown

If not, why? Not applicable

5. Was staff assistance given for the formulation and contractual implementation of LCC models and analyses used? Yes

Was it available? Yes

6. Was staff assistance given for the evaluation of data derived from LCC models or analyses used? Yes

Was it available? Yes

7. Could the models and analyses be run and verified on computer systems available to the government? No--they were run by the contractor

If so, could the modeling and analyses be performed on IBM compatible PCs, or were larger mainframe computers required? Not applicable

8. Do you believe that LCC models which can be run on IBM compatible PCs would provide for more effective LCC management? Not really--there is a lack of time to run them and to analyze the data

9. Do you have any recommendations for improving the modeling and analyses for LCC? In the program being discussed the contractor runs the LCC models as specified and the Government uses the information for decision making

General Comments

1. Do you have any general or specific comments that you would like to add regarding LCC? A lot of boilerplating goes on during the putting together of requirements (partially due to the lack of familiarity with LCC and partly because of the maze of requirements which must be considered)--this results in our getting a lot of data that is not required and that we do not really understand

Interviewee/Program Information

Interview Number: 6

1. How many years experience do you have in acquisition logistics? 7

At what level? ILSM

2. Do you have any formal LCC training or experience? No

LCC drivers and Potential for Savings

1. In order of significance (cost), what are the three largest LCC drivers for your program?

a. Integration of software

b. Maintenance/manpower

c. Depot costs

2. In view of the control you are allowed to exercise, which of the mentioned LCC drivers afford the greatest potential for savings? Maintenance/manpower

Why? Due to the ability to elevate and highlight the issues in the system design process and to defer requirements while waiting for technology to mature

3. What changes, if any, do you feel would allow you to more effectively achieve LCC savings? There is a need to be able to do modeling to generate hard facts and figures with regard to the cost structure--this will provide ammunition required to convince program management and engineering types of possible cost benefits (without this it boils down to is the typical cost-schedule-performance-support situation where support is ignored)

Timing of LCC Emphasis

1. In which phase of the acquisition process did LCC first become a contractual concern (pre-conceptual, conceptual, dem/val, FSED, or production)? Conceptual

What was required contractually? The contractor was required to develop the appropriate plans, and LCC and DTC information established in the demonstration/validation phase was used to proceed into FSED

2. Was LCC considered during the design effort? Yes

3. Was LCC a consideration for contract award? Yes

In what way? LCC and DTC results of competing contractors was evaluated in source selection

Most Effective Period for LCC Emphasis

1. Which phase of the acquisition process do you feel represents the greatest opportunity to address LCC? Demonstation/validation

Guidance and Direction

1. What guidance and direction do you reference for LCC management? 800-series regulations

2. Do you believe that you are addressing LCC in the manner envisioned by existing guidance and direction, or that the requirement is simply being met? Filling a square

Impediments to Integrating LCC and Their Elimination

1. What impediments exist to integrating LCC into the decision making process (upper level commitment, guidance and direction, manpower, expertise, time, funds, etc.), and how would you rank them?

a. Manpower increases would give you the resources to convince management of our needs

b. Guidance and direction should provide for the development of a data base or tool which would allow us to look at the cost of various options--an improved centrally located data base which tracked new technologies would provide program offices with information needed for analyses, and eliminate the need to duplicate previously accomplished work

c. A properly manned core staff of experts would help--currently the logistics offices are responsible for LCC management but they are not provided with the

expertise, and this is complicated by a staff that is spread to thin (and therefore often unavailable to help)

Cost Estimating Models and Analysis

1. Are you familiar with the various LCC modeling techniques which are most commonly used in your program? Yes

2. What LCC models or analyses techniques were used in the various stages of your program? LCC-10A and a modified LCC-2A were used (the data had to be massaged in for use in both models in order to be appropriate for the system involved)

3. How was the information used (as data for entry into the next phase, for trade off studies, for engineering analyses, etc.)? Trade-off studies and engineering analyses

4. Were competing contractors required to use the same LCC models and analyses techniques? Not determined as of yet

If not, why? Not applicable

5. Was staff assistance given for the formulation and contractual implementation of LCC models and analyses used? No

Was it available? Due to the requirement to forecast the workload in order to get staff assistance its availability was limited

6. Was staff assistance given for the evaluation of data derived from LCC models or analyses used? No

Was it available? Due to the requirement to forecast the workload in order to get staff assistance its availability was limited

7. Could the models and analyses be run and verified on computer systems available to the government? Yes

If so, could the modeling and analyses be performed on IBM compatible PCs, or were larger mainframe computers required? Mainframe

8. Do you believe that LCC models which can be run on IBM compatible PCs would provide for more effective LCC management? No--the people and the time and experience required to load, run, and analyze the data do not exist

9. Do you have any recommendations for improving the modeling and analyses for LCC? DOD should designate a limited number of joint service models so that guesswork could be eliminated and data would be comparable (program personnel could brief using the same models, terms, criteria, etc.)--Despite flaws that exist in this approach it is better than the thousands of different models that people are currently trying to track and understand

General Comments

1. Do you have any general or specific comments that you would like to add regarding LCC? There is a serious problem with the fact that the DPML/ILSM is responsible for LCC without having the authority to manage it as required--the program manager (who holds the purse strings and who ultimately makes the decisions) should designate a project

officer and provide the resources required

Interviewee/Program Information

Interview Number: 7

1. How many years experience do you have in acquisition logistics? 1.5

At what level? ILSM

2. Do you have any formal LCC training or experience? No

LCC drivers and Potential for Savings

1. In order of significance (cost), what are the three largest LCC drivers for your program?

a. End Item

b. Maintenance (contracted logistics support for repair of spares and SE)

c. (None given)

2. In view of the control you are allowed to exercise, which of the mentioned LCC drivers afford the greatest potential for savings? Contracted logistics support for the system

Why? Spares and support equipment are subject to trade offs

3. What changes, if any, do you feel would allow you to more effectively achieve LCC savings? None

Timing of LCC Emphasis

1. In which phase of the acquisition process did LCC first become a contractual concern (pre-conceptual, conceptual, dem/val, FSED, or production)? FSED

What was required contractually? The LCC costs were part of the contractor's bid and not considered seperately

2. Was LCC considered during the design effort? Unknown--was not involved in the program at that time

3. Was LCC a consideration for contract award? No--due to the nature of the contract (contractor support)

In what way? Not applicable

Most Effective Period for LCC Emphasis

1. Which phase of the acquisition process do you feel represents the greatest opportunity to address LCC? FSED

Guidance and Direction

1. What guidance and direction do you reference for LCC management? 800-series regulations (but LCC experts at staff or the LCC monitor for the division are normally the source of information)

2. Do you believe that you are addressing LCC in the manner envisioned by existing guidance and direction, or that the requirement is simply being met? Simply being met

Impediments to Integrating LCC and Their Elimination

1. What impediments exist to integrating LCC into the decision making process (upper level commitment, guidance and direction, manpower, expertise, time, funds, etc.), and how would you rank them?

a. Time is the biggest constraint--90 day source selections on streamlined acquisitions and situations where concurrency or overlapping of program phases is required make it difficult (if not impossible) to properly apply

LCC--LCC takes time to do correctly and cannot be done with limited data

b. Expertise is lacking

c. Guidance and direction is geared towards organic (Air Force) support--when logistics support is contracted out, LCC is difficult to apply

Cost Estimating Models and Analysis

1. Are you familiar with the various LCC modeling techniques which are most commonly used in your program? No

2. What LCC models or analyses techniques were used in the various stages of your program? Not sure--possibly Cost Analysis Strategy Assessment (CASA)

3. How was the information used (as data for entry into the next phase, for trade off studies, for engineering analyses, etc.)? Not sure--probably as a square filler

4. Were competing contractors required to use the same LCC models and analyses techniques? No

If not, why? Program was sole source

5. Was staff assistance given for the formulation and contractual implementation of LCC models and analyses used? No--contract support was used for LCC effort

Was it available? Unknown

6. Was staff assistance given for the evaluation of data derived from LCC models or analyses used? No--contract support was used for the LCC effort

Was it available? Unknown

7. Could the models and analyses be run and verified on computer systems available to the government? Yes

If so, could the modeling and analyses be performed on IBM compatible PCs, or were larger mainframe computers required? IBM compatible PCs

8. Do you believe that LCC models which can be run on IBM compatible PCs would provide for more effective LCC management? No--logisticians do not have the time or expertise

9. Do you have any recommendations for improving the modeling and analyses for LCC? Simplify the modeling and make it user friendly--give up accuracy for simplicity--make more LCC training or experts available

General Comments

1. Do you have any general or specific comments that you would like to add regarding LCC? Logisticians should not be responsible for LCC unless they are given the authority required to implement decisions and to make timing allowances

Interviewee/Program Information

Interview Number: 8

1. How many years experience do you have in acquisition logistics? 5

At what level? ILSM

2. Do you have any formal LCC training or experience? QMT 353 at AFIT

LCC drivers and Potential for Savings

1. In order of significance (cost), what are the three largest LCC drivers for your program?

a. SE

b. Spares

c. Technical Data

2. In view of the control you are allowed to exercise, which of the mentioned LCC drivers afford the greatest potential for savings? Technical Data

Why? The program uses contracted logistics support, therefore, technical data is the area that can be worked the most

3. What changes, if any, do you feel would allow you to more effectively achieve LCC savings? Use as much off-the-shelf (commercial) equipment as possible

Timing of LCC Emphasis

1. In which phase of the acquisition process did LCC first become a contractual concern (pre-conceptual, conceptual, dem/val, FSED, or production)? Not applied--off-the-shelf equipment was used

What was required contractually? The only requirement (with regards to LCC) was that it be a consideration in the contractor's proposal

2. Was LCC considered during the design effort? Yes

3. Was LCC a consideration for contract award? Yes

In what way? As one of the source selection criteria (was to be a tie-breaker if all other criteria were equal)

Most Effective Period for LCC Emphasis

1. Which phase of the acquisition process do you feel represents the greatest opportunity to address LCC? Conceptual (because LCC can be planned for)

Guidance and Direction

1. What guidance and direction do you reference for LCC management? Program Management Directive PMD and 800-series regulations

2. Do you believe that you are addressing LCC in the manner envisioned by existing guidance and direction, or that the requirement is simply being met? Simply being met

Impediments to Integrating LCC and Their Elimination

1. What impediments exist to integrating LCC into the decision making process (upper level commitment, guidance and direction, manpower, expertise, time, funds, etc.), and how would you rank them?

a. Expertise is lacking

b. (None given)

c. (None given)

Cost Estimating Models and Analysis

1. Are you familiar with the various LCC modeling techniques which are most commonly used in your program? No

2. What LCC models or analyses techniques were used in the various stages of your program? Do not know

3. How was the information used (as data for entry into the next phase, for trade off studies, for engineering

analyses, etc.)? Do not know

4. Were competing contractors required to use the same LCC models and analyses techniques? Do not know

If not, why? Unknown

5. Was staff assistance given for the formulation and contractual implementation of LCC models and analyses used? Yes

Was it available? Yes

6. Was staff assistance given for the evaluation of data derived from LCC models or analyses used? Yes

Was it available? Yes

7. Could the models and analyses be run and verified on computer systems available to the government? Do not know what models might have been run

If so, could the modeling and analyses be performed on IBM compatible PCs, or were larger mainframe computers required? Do not know

8. Do you believe that LCC models which can be run on IBM compatible PCs would provide for more effective LCC management? Do not know

9. Do you have any recommendations for improving the modeling and analyses for LCC? No

General Comments

1. Do you have any general or specific comments that you would like to add regarding LCC? LCC and O&S costs are ignored in favor of the immediate acquisition costs--We are responsible but have no authority

## Interviewee/Program Information

Interview Number: 9

1. How many years experience do you have in acquisition logistics? 6

   At what level? ILSM

2. Do you have any formal LCC training or experience? No

## LCC drivers and Potential for Savings

1. In order of significance (cost), what are the three largest LCC drivers for your program?

   a. O&S

   b. Modifications

   c. Software

2. In view of the control you are allowed to exercise, which of the mentioned LCC drivers afford the greatest potential for savings? O&S

   Why? O&S is contracted out and can be competed

3. What changes, if any, do you feel would allow you to more effectively achieve LCC savings? None

## Timing of LCC Emphasis

1. In which phase of the acquisition process did LCC first become a contractual concern (pre-conceptual, conceptual, dem/val, FSED, or production)? FSED

   What was required contractually? Trade-off studies

2. Was LCC considered during the design effort? Not sure

3. Was LCC a consideration for contract award? Yes

   In what way? As one of the criteria for selection

Most Effective Period for LCC Emphasis

1. Which phase of the acquisition process do you feel represents the greatest opportunity to address LCC? Conceptual

Guidance and Direction

1. What guidance and direction do you reference for LCC management? 800-series regulations

2. Do you believe that you are addressing LCC in the manner envisioned by existing guidance and direction, or that the requirement is simply being met? As envisioned

Impediments to Integrating LCC and Their Elimination

1. What impediments exist to integrating LCC into the decision making process (upper level commitment, guidance and direction, manpower, expertise, time, funds, etc.), and how would you rank them?

a. Upper level commitment is required or LCC becomes a square filling exercise

b. More expertise is required

c. Guidance and direction

Cost Estimating Models and Analysis

1. Are you familiar with the various LCC modeling techniques which are most commonly used in your program? Vaguely

2. What LCC models or analyses techniques were used in the various stages of your program? CASA

3. How was the information used (as data for entry into the next phase, for trade off studies, for engineering

analyses, etc.)? Trade-off studies for various modifications

4. Were competing contractors required to use the same LCC models and analyses techniques? Yes

If not, why? Not applicable

5. Was staff assistance given for the formulation and contractual implementation of LCC models and analyses used? Yes

Was it available? Yes

6. Was staff assistance given for the evaluation of data derived from LCC models or analyses used? Yes

Was it available? Yes

7. Could the models and analyses be run and verified on computer systems available to the government? Yes

If so, could the modeling and analyses be performed on IBM compatible PCs, or were larger mainframe computers required? IBM compatible PCs

8. Do you believe that LCC models which can be run on IBM compatible PCs would provide for more effective LCC management? Yes--if the program is small enough to work and the data base is already developed

9. Do you have any recommendations for improving the modeling and analyses for LCC? No

General Comments

1. Do you have any general or specific comments that you would like to add regarding LCC? Give it to the people who are qualified and have the time and the resources needed

## Interviewee/Program Information

Interview Number: 10

1. How many years experience do you have in acquisition logistics? 2.5

At what level? ILSM

2. Do you have any formal LCC training or experience? QMT 353

## LCC drivers and Potential for Savings

1. In order of significance (cost), what are the three largest LCC drivers for your program?

a. Contractor training

b. Manpower

c. Spares

2. In view of the control you are allowed to exercise, which of the mentioned LCC drivers afford the greatest potential for savings? Training

Why? Improved training and training equipment achieve significant savings

3. What changes, if any, do you feel would allow you to more effectively achieve LCC savings? Long term contracts

## Timing of LCC Emphasis

1. In which phase of the acquisition process did LCC first become a contractual concern (pre-conceptual, conceptual, dem/val, FSED, or production)? Conceptual

What was required contractually? Unknown--LCC considerations were included in a Firm Fixed Price (FFP) contract and the contract was competed

2. Was LCC considered during the design effort? Unknown

3. Was LCC a consideration for contract award? Only is the sense that it affects total contract price

In what way? Not applicable

Most Effective Period for LCC Emphasis

1. Which phase of the acquisition process do you feel represents the greatest opportunity to address LCC? Conceptual

Guidance and Direction

1. What guidance and direction do you reference for LCC management? None--not required for the FFP contract involved

2. Do you believe that you are addressing LCC in the manner envisioned by existing guidance and direction, or that the requirement is simply being met? As envisioned

Impediments to Integrating LCC and Their Elimination

1. What impediments exist to integrating LCC into the decision making process (upper level commitment, guidance and direction, manpower, expertise, time, funds, etc.), and how would you rank them?

a. Expertise is lacking (although less sophisticated analyses done by untrained logistics personnel often prove to be as accurate as the more complex and time consuming models)

b. Time to do detailed analyses is not available

c. Guidance and direction is complex and hard to apply

Cost Estimating Models and Analysis

1. Are you familiar with the various LCC modeling techniques which are most commonly used in your program? LCC modeling was not used--Somewhat familiar with typical models

2. What LCC models or analyses techniques were used in the various stages of your program? None

3. How was the information used (as data for entry into the next phase, for trade off studies, for engineering analyses, etc.)? Any trade off studies done did not involve LCC modeling--end cost was the primary concern since program involved a FFP contract

4. Were competing contractors required to use the same LCC models and analyses techniques? No

If not, why? Lowest bid on contract was only concern

5. Was staff assistance given for the formulation and contractual implementation of LCC models and analyses used? No

Was it available? Unknown

6. Was staff assistance given for the evaluation of data derived from LCC models or analyses used? No

Was it available? Unknown

7. Could the models and analyses be run and verified on computer systems available to the government? Not applicable

If so, could the modeling and analyses be performed on IBM compatible PCs, or were larger mainframe computers required? Not applicable

8. Do you believe that LCC models which can be run on IBM compatible PCs would provide for more effective LCC management? Do not have faith in the available LCC models

9. Do you have any recommendations for improving the modeling and analyses for LCC? Keep it simple--over analyses is not paying off--if FFP contract is involved take the lowest qualified bid since LCC costs are included in the contract price

General Comments

1. Do you have any general or specific comments that you would like to add regarding LCC? Too many requirements for expensive (and often unreliable) LCC data that often goes unused

Interviewee/Program Information

Interview Number: 11

1. How many years experience do you have in acquisition logistics? 10

At what level? DPML

2. Do you have any formal LCC training or experience? AFIT QMT 353 and two day LCC and DTC seminar

LCC drivers and Potential for Savings

1. In order of significance (cost), what are the three largest LCC drivers for your program?

a. Hardware

b. (None given)

c. (None given)

2. In view of the control you are allowed to exercise, which of the mentioned LCC drivers afford the greatest potential for savings? Hardware

Why? Because the program involves hardware upgrades

3. What changes, if any, do you feel would allow you to more effectively achieve LCC savings? None for the type of program involved

Timing of LCC Emphasis

1. In which phase of the acquisition process did LCC first become a contractual concern (pre-conceptual, conceptual, dem/val, FSED, or production)? The modification did not involve LCC analyses

What was required contractually? Not applicable

2. Was LCC considered during the design effort? Not applicable

3. Was LCC a consideration for contract award? Not applicable

In what way? Not applicable

Most Effective Period for LCC Emphasis

1. Which phase of the acquisition process do you feel represents the greatest opportunity to address LCC? Conceptual

Guidance and Direction

1. What guidance and direction do you reference for LCC management? 800-series regulations and ILS Guide for Acquisition Managers

2. Do you believe that you are addressing LCC in the manner envisioned by existing guidance and direction, or that the requirement is simply being met? As envisioned

Impediments to Integrating LCC and Their Elimination

1. What impediments exist to integrating LCC into the decision making process (upper level commitment, guidance and direction, manpower, expertise, time, funds, etc.), and how would you rank them?

a. Upper level commitment is lacking in Program Managers and engineers who do not realize the significance or fully appreciate the benefits of a good LCC program

b. Manpower is a problem and you have to pull teeth to get help

c. Expertise is lacking

Cost Estimating Models and Analysis

1. Are you familiar with the various LCC modeling techniques which are most commonly used in your program? Partially

2. What LCC models or analyses techniques were used in the various stages of your program? LCC-2, Dyna-METRIC, L-COMM, and CORE

3. How was the information used (as data for entry into the next phase, for trade off studies, for engineering analyses, etc.)? Primarily as a source selection criteria

4. Were competing contractors required to use the same LCC models and analyses techniques? Yes

If not, why? Not applicable

5. Was staff assistance given for the formulation and contractual implementation of LCC models and analyses used? Yes

Was it available? Yes

6. Was staff assistance given for the evaluation of data derived from LCC models or analyses used? Yes

Was it available? Yes

7. Could the models and analyses be run and verified on computer systems available to the government? Yes

If so, could the modeling and analyses be performed on IBM compatible PCs, or were larger mainframe computers required? IBM compatible PCs

8. Do you believe that LCC models which can be run on IBM compatible PCs would provide for more effective LCC management? Sometimes

9. Do you have any recommendations for improving the modeling and analyses for LCC? No

General Comments

1. Do you have any general or specific comments that you would like to add regarding LCC? No

Interviewee/Program Information

Interview Number: 12

1. How many years experience do you have in acquisition logistics? 3

At what level? ILSM

2. Do you have any formal LCC training or experience? No

LCC drivers and Potential for Savings

1. In order of significance (cost), what are the three largest LCC drivers for your program?

a. Spares

b. Software

c. Technical data

2. In view of the control you are allowed to exercise, which of the mentioned LCC drivers afford the greatest potential for savings? Spares and technical data

Why? Software is more difficult to manipulate

3. What changes, if any, do you feel would allow you to more effectively achieve LCC savings? Configuration management of spares (maintaining concurrency) needs to be improved

Timing of LCC Emphasis

1. In which phase of the acquisition process did LCC first become a contractual concern (pre-conceptual, conceptual, dem/val, FSED, or production)? Before FSED

What was required contractually? LCC management plan

2. Was LCC considered during the design effort? Do not know

3. Was LCC a consideration for contract award? Since this was a FFP contract LCC management was the only real consideration

In what way? As one of many criteria for selection

Most Effective Period for LCC Emphasis

1. Which phase of the acquisition process do you feel represents the greatest opportunity to address LCC? Conceptual usually (FSED is more appropriate for working LCC concerns and issues if you are purchasing off-the-shelf equipment)

## Guidance and Direction

1. What guidance and direction do you reference for LCC management? 800-series regulations

2. Do you believe that you are addressing LCC in the manner envisioned by existing guidance and direction, or that the requirement is simply being met? Simply being met

## Impediments to Integrating LCC and Their Elimination

1. What impediments exist to integrating LCC into the decision making process (upper level commitment, guidance and direction, manpower, expertise, time, funds, etc.), and how would you rank them?

   a. Expertise

   b. Manpower

   c. Time

## Cost Estimating Models and Analysis

1. Are you familiar with the various LCC modeling techniques which are most commonly used in your program? Vaguely

2. What LCC models or analyses techniques were used in the various stages of your program? CASA

3. How was the information used (as data for entry into the next phase, for trade off studies, for engineering analyses, etc.)? Trade-off studies

4. Were competing contractors required to use the same LCC models and analyses techniques? No

   If not, why? Because off-the-shelf equipment was purchased

5. Was staff assistance given for the formulation and contractual implementation of LCC models and analyses used? No

Was it available? Unknown

6. Was staff assistance given for the evaluation of data derived from LCC models or analyses used? No

Was it available? Unknown

7. Could the models and analyses be run and verified on computer systems available to the government? Yes

If so, could the modeling and analyses be performed on IBM compatible PCs, or were larger mainframe computers required? IBM compatible PCs

8. Do you believe that LCC models which can be run on IBM compatible PCs would provide for more effective LCC management? Not necessarily--models are usually too complicated and often do not represent the system being modeled

9. Do you have any recommendations for improving the modeling and analyses for LCC? Expertise needs to be available in order to fit the model to the program--LCC costing models for O&S of software need to be made available

General Comments

1. Do you have any general or specific comments that you would like to add regarding LCC? Logisticians cannot and should not be responsible since they do not have the models or the experience--an LCC office should be established and

be made fully responsible--contractors are not incentivized to create supportable systems since they make money on spares

Interviewee/Program Information

Interview Number: 13

1. How many years experience do you have in acquisition logistics? 2

At what level? DPML

2. Do you have any formal LCC training or experience? No

LCC drivers and Potential for Savings

1. In order of significance (cost), what are the three largest LCC drivers for your program?

(None given--interviewee contended that for the firm fixed price incentive [FFPI] contract involved LCC drivers were not an issue)

2. In view of the control you are allowed to exercise, which of the mentioned LCC drivers afford the greatest potential for savings? None

Why? Not applicable

3. What changes, if any, do you feel would allow you to more effectively achieve LCC savings? None

Timing of LCC Emphasis

1. In which phase of the acquisition process did LCC first become a contractual concern (pre-conceptual, conceptual, dem/val, FSED, or production)? Not applicable--FFPI program

What was required contractually? Not applicable

2. Was LCC considered during the design effort? Not applicable

3. Was LCC a consideration for contract award? No

In what way? Not applicable

Most Effective Period for LCC Emphasis

1. Which phase of the acquisition process do you feel represents the greatest opportunity to address LCC? Conceptual

Guidance and Direction

1. What guidance and direction do you reference for LCC management? None--the LCC monitor for the office is used if LCC issues arise

2. Do you believe that you are addressing LCC in the manner envisioned by existing guidance and direction, or that the requirement is simply being met? LCC is not applicable for the type of program involved

Impediments to Integrating LCC and Their Elimination

1. What impediments exist to integrating LCC into the decision making process (upper level commitment, guidance and direction, manpower, expertise, time, funds, etc.), and how would you rank them?

None

Cost Estimating Models and Analysis

1. Are you familiar with the various LCC modeling techniques which are most commonly used in your program? Vaguely

2. What LCC models or analyses techniques were used in the various stages of your program? Z-CORE was used in source selection

3. How was the information used (as data for entry into the next phase, for trade off studies, for engineering analyses, etc.)? Unknown

4. Were competing contractors required to use the same LCC models and analyses techniques? Yes

If not, why? Not applicable

5. Was staff assistance given for the formulation and contractual implementation of LCC models and analyses used? Yes

Was it available? Yes

6. Was staff assistance given for the evaluation of data derived from LCC models or analyses used? Yes

Was it available? Yes

7. Could the models and analyses be run and verified on computer systems available to the government? Yes

If so, could the modeling and analyses be performed on IBM compatible PCs, or were larger mainframe computers required? IBM compatible PCs

8. Do you believe that LCC models which can be run on IBM compatible PCs would provide for more effective LCC management? Yes

9. Do you have any recommendations for improving the modeling and analyses for LCC? No

## General Comments

1. Do you have any general or specific comments that you would like to add regarding LCC? No

## Interviewee/Program Information

Interview Number: 14

1. How many years experience do you have in acquisition logistics? 2

   At what level? ILSM

2. Do you have any formal LCC training or experience? QMT 353

## LCC drivers and Potential for Savings

1. In order of significance (cost), what are the three largest LCC drivers for your program?

   a. Transportation

   b. Reliability

   c. (None given)

2. In view of the control you are allowed to exercise, which of the mentioned LCC drivers afford the greatest potential for savings? Reliability

   Why? Transportability incentives are built into contract and have not had to be worked

3. What changes, if any, do you feel would allow you to more effectively achieve LCC savings? None

## Timing of LCC Emphasis

1. In which phase of the acquisition process did LCC first become a contractual concern (pre-conceptual, conceptual, dem/val, FSED, or production)? Conceptual

What was required contractually? Trade-off studies and Warranty

2. Was LCC considered during the design effort? Yes

3. Was LCC a consideration for contract award? No

In what way? Not applicable

Most Effective Period for LCC Emphasis

1. Which phase of the acquisition process do you feel represents the greatest opportunity to address LCC? Conceptual

Guidance and Direction

1. What guidance and direction do you reference for LCC management? 800-series regulation

2. Do you believe that you are addressing LCC in the manner envisioned by existing guidance and direction, or that the requirement is simply being met? As envisioned

Impediments to Integrating LCC and Their Elimination

1. What impediments exist to integrating LCC into the decision making process (upper level commitment, guidance and direction, manpower, expertise, time, funds, etc.), and how would you rank them?

a. Expertise is needed to understand the models and what they are intended to do--expertise is also needed to format and interpret the data

b. Guidance and direction is geared towards major programs and often not appropriate for less-than-major programs

c. Upper level commitment is sometimes lacking

## Cost Estimating Models and Analysis

1. Are you familiar with the various LCC modeling techniques which are most commonly used in your program? Very vaguely

2. What LCC models or analyses techniques were used in the various stages of your program? Trade studies

3. How was the information used (as data for entry into the next phase, for trade off studies, for engineering analyses, etc.)? Trade-off studies, engineering analyses, and for entry into the next phase

4. Were competing contractors required to use the same LCC models and analyses techniques? No

If not, why? Not applicable due to the nature of the contract

5. Was staff assistance given for the formulation and contractual implementation of LCC models and analyses used? Yes

Was it available? Yes

6. Was staff assistance given for the evaluation of data derived from LCC models or analyses used? Yes

Was it available? Yes

7. Could the models and analyses be run and verified on computer systems available to the government? Yes

If so, could the modeling and analyses be performed on IBM compatible PCs, or were larger mainframe computers required? Unknown

8. Do you believe that LCC models which can be run on IBM compatible PCs would provide for more effective LCC management? Yes

9. Do you have any recommendations for improving the modeling and analyses for LCC? More expertise

General Comments

1. Do you have any general or specific comments that you would like to add regarding LCC? No

Interviewee/Program Information

Interview Number: 15

1. How many years experience do you have in acquisition logistics? 1.5

At what level? DPML

2. Do you have any formal LCC training or experience? QMT 353 and DPML course

LCC drivers and Potential for Savings

1. In order of significance (cost), what are the three largest LCC drivers for your program?

a. Manpower

b. Fuel

c. SE

2. In view of the control you are allowed to exercise, which of the mentioned LCC drivers afford the greatest potential for savings? Manpower

Why? Manpower comprises the bulk of the effort and automation can be substituted to effect cost savings

3. What changes, if any, do you feel would allow you to more effectively achieve LCC savings? More real time analyses with prototype or firmer design--more rapid turn-around on analyses (administrative requirements eat up much of the time available)--more and better experts are needed

Timing of LCC Emphasis

1. In which phase of the acquisition process did LCC first become a contractual concern (pre-conceptual, conceptual, dem/val, FSED, or production)? FSED

What was required contractually? Baseline LCC and effects of changes to baseline

2. Was LCC considered during the design effort? Yes

3. Was LCC a consideration for contract award? Yes

In what way? Criteria for selection

Most Effective Period for LCC Emphasis

1. Which phase of the acquisition process do you feel represents the greatest opportunity to address LCC? Conceptual planning is required but hardware (available in FSED) is needed to adequately analyze

Guidance and Direction

1. What guidance and direction do you reference for LCC management? 800-series regulations, Staff, and ALT [Acquisition Logistics Concepts and Analysis Branch] handbooks

2. Do you believe that you are addressing LCC in the manner envisioned by existing guidance and direction, or that the requirement is simply being met? As envisioned

Impediments to Integrating LCC and Their Elimination

1. What impediments exist to integrating LCC into the decision making process (upper level commitment, guidance and direction, manpower, expertise, time, funds, etc.), and how would you rank them?

a. Expertise is lacking

b. Time is lacking

c. Manpower is lacking

Cost Estimating Models and Analysis

1. Are you familiar with the various LCC modeling techniques which are most commonly used in your program? Vaguely

2. What LCC models or analyses techniques were used in the various stages of your program? A modified Z-CORE model

3. How was the information used (as data for entry into the next phase, for trade off studies, for engineering analyses, etc.)? Trade-off studies

4. Were competing contractors required to use the same LCC models and analyses techniques? Yes

If not, why? Not applicable

5. Was staff assistance given for the formulation and contractual implementation of LCC models and analyses used? Yes

Was it available? Yes

6. Was staff assistance given for the evaluation of data derived from LCC models or analyses used? Yes

Was it available? Yes

7. Could the models and analyses be run and verified on computer systems available to the government? Yes

If so, could the modeling and analyses be performed on IBM compatible PCs, or were larger mainframe computers required? IBM compatible PCs

8. Do you believe that LCC models which can be run on IBM compatible PCs would provide for more effective LCC management? Yes--assuming experienced personnel are available

9. Do you have any recommendations for improving the modeling and analyses for LCC? We need the capability to use less complicated and less time consuming models; although a degree of accuracy may be lost most mistakes would balance out between competing systems

General Comments

1. Do you have any general or specific comments that you would like to add regarding LCC? LCC data generated using complicated models can lie and be very hard to understand--simpler models will facilitate and increase usage (heuristics is often adequate)--LCC modeling often involves duplication of effort--low LCC does not equate to combat capability

Appendix D: Interview Subjects and Program Data

| ASD SYMBOL | RANK | NAME |
|---|---|---|
| AEGL | GS-12 | Tim McKenzie |

SYSTEM: Depot Automatic Test System Avionics (DATSA)

POSITION: ILSM

PROGRAM SIZE: Less-Than-Major

APPROXIMATE PROGRAM COST (R&D AND PRODUCTION): 10 Million

| ASD SYMBOL | RANK | NAME |
|---|---|---|
| AESL | GS-12 | Donald Gott |

SYSTEM: Anti-Drown System

POSITION: ILSM

PROGRAM SIZE: Less-Than-Major

APPROXIMATE PROGRAM COST (R&D AND PRODUCTION): 5 Million

| ASD SYMBOL | RANK | NAME |
|---|---|---|
| AFTL | Lt. Col. | Gregory W. Sutton |

SYSTEM: T-46

POSITION: DPML

PROGRAM SIZE: Major

APPROXIMATE PROGRAM COST (R&D AND PRODUCTION): 7 Billion

| ASD SYMBOL | RANK | NAME |
|---|---|---|
| AFZL | GS-12 | Frank W. Massey |

SYSTEM: AC-130U

POSITION: DPML

PROGRAM SIZE: Less-Than-Major

APPROXIMATE DOLLAR COST (R&D AND PRODUCTION): 653.8 Million

| ASD SYMBOL | RANK | NAME |
|---|---|---|
| RWJL | Capt. | Eva Nunley |

SYSTEM: F/FB/EF-111 SPS

POSITION: ILSM

PROGRAM SIZE: Less-Than-Major

APPROXIMATE DOLLAR COST (R&D AND PRODUCTION): 49 Million

| ASD SYMBOL | RANK | NAME |
|---|---|---|
| RWNL | Major | Larry Block |

SYSTEM: LANTIRN

POSITION: DPML

PROGRAM SIZE: Major

APPROXIMATE DOLLAR COST (R&D AND PRODUCTION): 4.1 Billion

| ASD SYMBOL | RANK | NAME |
|---|---|---|
| RWQL | Capt. | Terry Emerine |

SYSTEM: PLSS

POSITION: DPML

PROGRAM SIZE: Major

APPROXIMATE DOLLAR COST (R&D AND PRODUCTION): 1 Billion

| ASD SYMBOL | RANK | NAME |
|---|---|---|
| RWWL | GS-13 | Alice Gibson |

SYSTEM: INEWS

POSITION: ILSM

PROGRAM SIZE: Major

APPROXIMATE DOLLAR COST (R&D AND PRODUCTION): Unavailable

| ASD SYMBOL | RANK | NAME |
|---|---|---|
| TAAL | GM-13 | Jeffrey L. Cowgill |

SYSTEM: A-7 UPGRADE

POSISITON: DPML

PROGRAM SIZE: Less-Than-Major

APPROXIMATE DOLLAR COST (R&D AND PRODUCTION): Unavailable

| ASD SYMBOL | RANK | NAME |
|---|---|---|
| TAML | Major | Boyd Stevens |

SYSTEM: MAVERICK MISSILE

POSITION: DPML

PROGRAM SIZE: Major

APPROXIMATE DOLLAR COST (R&D AND PRODUCTION): 7 Billion

| ASD SYMBOL | RANK | NAME |
|---|---|---|
| YWLF | GS-12 | James L. Sanderson |

SYSTEM: ADF

POSITION: ILSM

PROGRAM SIZE: Less-Than-Major

APPROXIMATE DOLLAR COST (R&D AND PRODUCTION): 63 Million

| ASD SYMBOL | RANK | NAME |
|---|---|---|
| YWLF | Capt. | Kurt P. Hays |

SYSTEM: F-15E WST

POSITION: ILSM

PROGRAM SIZE: Less-Than-Major

APPROXIMATE DOLLAR COST (R&D AND PRODUCTION): 250 Million

| ASD SYMBOL | RANK | NAME |
|---|---|---|
| YWLS | GS-12 | David L. Wellmeier |

SYSTEM: C-17 ATS

POSITION: ILSM

PROGRAM SIZE: Less-Than-Major

APPROXIMATE DOLLAR COST (R&D AND PRODUCTION): 500 Million

| ASD SYMBOL | RANK | NAME |
|---|---|---|
| YWLS | GS-12 | James T. Granger |

SYSTEM: C-130 ATS

POSITION: ILSM

PROGRAM SIZE: Less-Than-Major

APPROXIMATE DOLLAR COST (R&D AND PRODUCTION): 270 Million

| ASD SYMBOL | RANK | NAME |
|---|---|---|
| YWLS | 1Lt. | Galen E. Wellesley |

SYSTEM: C-5 BATS

POSITION: ILSM

PROGRAM SIZE: Less-Than-Major

APPROXIMATE DOLLAR COST (R&D AND PRODUCTION): 125 Million

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## Abstract

The conditions and events which served to highlight the fact that life cycle cost (LCC) had been ignored in the past and is being poorly utilized in the present are discussed. Mind-sets and faulty prioritizations which may prevent life cycle costing's successful implementation are also discussed. The significance of reliability and maintainability (R&M) to LCC, its role as the major LCC contributor, and its potential for greatest savings are addressed. The timing of LCC management emphasis and of trade offs, current guidance and direction, recommended methods of implementation, and current types of cost estimating models available and commonly utilized are also brought out.

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